ANNALS

OF

The Entomological Society of America

Volume XVII JUNE, 1924 Number 2

A STUDY OF THE OLFACTORY SENSE OF TERMITES.

(Twenty-four Figures).

RHODA A. HARTWELL,
Osborn Zoological Laboratory, Yale University,
New Haven, Conn.

INTRODUCTION.

The main object of this study has been to investigate the olfactory sense of the termite *Reticulitermes flavipes* (Kollar), with the purpose of subjecting to analysis McIndoo's assertion that the olfactory sense in insects is not located on the antennæ but on the legs and wings. While McIndoo and others have published a great deal on the olfactory sense of various insects, nothing has been done on the "white ants." The only work on termites which is at all related to this subject, is that by Stokes, dealing only with the morphological aspect and that only superficially. His observations regarding the distribution and external structure of the pores upon the legs agree in general with those in this paper though here a greater variation was found in the number of the pores. His paper is concerned in large measure with the morphology of the hairs and bristles, while this paper touches chiefly upon the morphology of the pores and short hairs (pegs) which might possibly be concerned with the sense of smell. He makes one extremely interesting observation which seems worthy of attention even though he does not lay much stress upon it. To quote, "with these organs, the termite is right well prepared for whatever may happen, even for the forceps of the predatory microscopist.

The forceps conquers in the end, but the insects seem to feel its presence before it touches them, retreating and sometimes backing away from it as from some obnoxious object."

It does not seem necessary to give a lengthy account of McIndoo's work, since this is quite generally known. He has studied in great detail the olfactory sense in Hymenoptera, Coleoptera, Lepidoptera, and Diptera, both from the morphological and experimental standpoints. Hicks, in 1857, described peculiar pore-like organs on the wings and halters of flies and on the wings of many other insects. In 1860 he discovered the same "vesicles" on the trochanters and femurs of all the insects he examined. He made the suggestion that these pores, because of their delicate structure, might, in some way, be connected with the sense of smell, or perhaps with some sense not found among Vertebrates, but he did not perform any experiments to substantiate his views.

McIndoo's work has been a detailed continuation, among other groups of insects, of the morphological study begun by Hicks, and in addition he has performed countless experiments by which he believes he has proved beyond question olfactory function of the pores.

Recently, however, many objections have been raised by Karl von Frisch in a paper entitled "Uber den Sitz des Geruchsinnes bei Insecten," in which he describes a series of very careful experiments upon bees, the results of which seem to indicate that the olfactory sense is located, not upon the legs and wings, but upon the antennæ. His new experimental methods will be discussed later, in connection with those of McIndoo, and the ones with which this paper is chiefly concerned, on the termites.

The study of this problem was carried on under the direction of Prof. Alexander Petrunkevitch, to whom I am greatly indebted for much of the material, as well as for many helpful suggestions and criticisms.

Materials and Methods.

For the study of the disposition and the morphology of the pores, specimens were at first boiled in potassium hydroxide, but it was soon found that specimens preserved in 70% alcohol and mounted in glycerine were much more satisfactory.

For the internal structure of the pores, live animals were fixed in Freihling's solution, heated to 40 or 50 degrees Centigrade. Other animals were fixed in Vom Rath's fluid, which is excellent for showing the nerves and the nerve cells. All specimens were cleared in cedar oil and imbedded in 45 or 54 degree paraffin. The posterior parts of the bodies of the termites were usually cut off in order to facilitate infiltration. For the study of the pores on the trochanters, single legs were oriented and imbedded separately, and sectioned at 5 μ. Sections in most cases were cut from 4 to 8 μ. in thickness. Sections fixed in Vom Rath's fluid seldom required staining, though in one or two cases where necessary, they were satisfactorily stained with Delafield's Hematoxylin. Sections fixed in Freihling's solution were stained in several ways. Iron Hematoxylin counterstained with Orange G being used most frequently.

Morphology.

Disposition.

In making a survey of the Hicks pores, about twelve workers were used. Specimens of soldiers and winged forms were examined for comparative purposes.

For convenience in discussion, the groups of pores have been numbered. Groups 1 and 2 are found on the trochanters of all the legs, Group 1 on the ventral side, Group 2 on the dorsal side. Group 3 is at the proximal end of the dorsal surface of the femur. Group 4 includes all the pores found on the antennæ with the exception of certain pores labelled 4a, which will be discussed later. Groups 5 and 6 are located on the mandibles, Group 5 on the dorsal side and Group 6 on the ventral. Group 7 is comprised of three pores found on the ventral side of the second segment of the maxillary palps. Group 7a are scattered pores and pegs on the distal edge of the galea of the maxilla. Group 8 refers to a single row of pores found along the galea of the labium on the dorsal side, and Group 9 to those more irregularly placed pores of a similar nature on the ventral side. The two marked rows of pores on the ventral surface of the labrum are called Group 10. There is a small group of pores on each side of the ventral surface of the hypopharynx, Group 11.

Very definite groups of short peg-like hairs have been observed, such as Group a, on the ventral median surface of

the coxæ, and Group b, on the trochanters at their articulations with the coxæ, on the concave side. Similar groups are found on the maxillary and labial palps at the basal portion of each segment close to the articulation. Those on the maxillary palps are called c_1, c_2, c_3, c_4, and c_5. Those on the labial palps are d_1, d_2, and d_3. Other groups of these hairs are present at the bases of the maxillæ, called c_6 and c_7. The small group at the very bases of the antennæ is referred to as Group f. There are some hairs covering the labrum which appear different from these other groups of peg-like hairs in that they lie extremely flat. These are called Group e.

These pores vary between the different groups in size and appearance, but the pores of the same group on different animals vary only slightly and then mainly in size, though there is some slight variation in the numbers in some of the groups. There is a definite gradation in the sensory structures, beginning with small, round pores without any conical elevations, to long, extremely stiff spines, such as are found on the edges of the galea of the maxillæ. At certain places on the body are found large, perfectly round pores which give the appearance of being the bases of medium sized hairs (e) after the hairs have been lost. Such, for instance, are the pores of Group 4a. Text figure 1, a and b, are diagrams of the appearance of the pores, and are found in Groups 1 through 11. Type b is the typical Hicks pore, such as is found in definite groups on the trochanters of the legs.

Pores on the Legs.

(Plate XIX, Figs. 1–8).

The distribution and type of the pores are the same on all the legs. Group 1 is found on the ventral side of the trochanter of each leg. This is the largest group and is a constant one. It is subdivided, in that four of its pores are a little to one side, lying in a row by themselves next to the line of articulation with the femur. Four is the usual number of this subgroup, but it is found to vary to a small degree, generally by not more than one. The other part of the group is distributed irregularly over the rest of the ventral side. This subgroup consists usually of ten pores, but may occasionally have as many as thirteen. All the pores of Group 1 are almond shaped, that is, somewhat elongated and pointed at each end. They are easily found with the medium and high powers of the microscope.

Group 2 is found in the position corresponding to that of Group 1, but on the dorsal side of the trochanter. This is a much smaller group of the same type of pores. The number of these is usually five, though in some cases four or six were present. These are as close together as those in Group 1, but being fewer in number, cover only a small portion of the dorsal surface.

Group 3 is very small but constant. It is at the proximal end of the femur close to the articulation of the femur with the trochanter, on the anterior dorsal surface. These vary in number from two to five, but they correspond on opposite legs. If the front left leg has three of these pores, the right front leg will possess the same number. The front pair of legs, however, may have three pores in this group, while the middle pair may have five, and the hind pair four.

Other pores have been seen on other parts of the legs but these are never constant and so are mentioned merely as being occasionally present. Such scattered pores are seldom of the type described above, but are the large round flat type which have been noticed on all parts of the body and which look as though they might be the bases of lost hairs. If these were constant, they might possibly be functional pores.

Pegs on the Legs.

There are certain groups of peg-like structures on each leg which should be described even though they may not have anything to do with the olfactory sense. These have been referred to as Groups a and b.

Group a is constant and is located on the ventral side of the coxa of each leg, close to the place where it articulates with the body. This is a group which at first sight might be taken for pores, because they appear as small bright spots in strong light. On focusing up, however, they were seen to possess extremely short processes like pegs. These short processes are about twice as long as their bases are wide, (type d). There are, on an average, ten of these structures, though they vary from nine to twelve.

Group b consists of similar structures on the ventral surface of the trochanter of each leg close to the articulation between it and the coxa. These vary in number from seven to twelve, with an average of ten. They are identical in structure with

those of Group a, and are very closely packed together. They are sometimes difficult to find because they are right in the bend of the leg, more anterior than ventral.

Pores on the Antennæ.

(Figs. 9 and 10).

The antennæ of the termite worker consist of sixteen segments. All of the pores on them have been called Group 4, though they are by no means arranged in a group. They are, however, constant in their location. On the dorsal side of each antenna, near the base of each segment, is found one single pore similar to those on the trochanters of the legs except that they are somewhat smaller, and, though a little elongated, are rounder. (Text Figure 1, a). A corresponding pore is found in the same position on the ventral side of each segment. On the dorsal side of the basal segment near the articulation of this segment with the second one, are two pores side by side. In one animal, three such pores were seen at the anterior part of the second segment, on the dorsal side. At the basal part of the first segment of the antenna on the distal side, close to the place where the antenna joins the head, is a small group of peg-like hairs such as were described on the legs (Group f). The pegs of this group vary in number from three to six. A similar group is sometimes present at the base of the second antennal segment.

Two long hairs are present both on the dorsal and on the ventral sides of the antennæ near the middle of each segment. In between these with many more to the anterior end of each segment, are smaller hairs which are about half the length of the longer ones. On some of the antennæ there appeared to be large perfectly round pores at the places where the two long hairs ordinarily were found. In some of the first specimens, there were so many of these that it seemed as though they were constant and were perhaps sensory pores, but the examination of more termites has led to the conclusion that these cannot be more than the bases of lost hairs. The hairs were found to be attached on some and absent on others. They were seldom absent from the same places on different segments. Some specimens were seen where all the hairs were present on all the antennæ and none of these round pores were observed. The small round true pores are, however, constant, though so few in number.

Mouth Parts.

Labrum.

(Plate XX, Fig. 15).

The most conspicuous pores on the labrum are found on the ventral side which is next to the other mouth-parts, fitting closely over the mandibles. These compose Group 10, and are arranged in two rows extending the entire length of the labrum, one on each side of the center line. They meet at the very anterior edge, forming a horse-shoe. The rest of the inner ventral surface is covered with very short fine hairs which lie extremely flat and all of which point toward the anterior midline. At the anterior edge of the labrum is a narrow row of bristles which project a little beyond the margin. Longer hairs are present in a fan-shaped arrangement at the articulation of the labrum with the palate. The pores of Group 10 appear flat when focused upon it one way, but when the lens is focused up they seem to be slightly raised, (Text Fig. 1, c). There is present quite a definite gradation of hairs into pores from the outside edge inwards. From the row of pores toward the midline, they grade back to short hairs.

Mandibles.

(Plate XX, Figs. 11–14).

Large groups of pores, Group 5 on the dorsal side, Group 6 on the ventral side, are found on the mandibles. These were examined in about eight specimens and were found to be extremely variable in both the number and position. They are not in any definite groups but are scattered about over the surface of the mandibles, usually nearer the articulation of the mandibles than the heavy chitinous rim. On the ventral side they are somewhat more separated into what might possibly be termed groups, than on the dorsal side. Here, in four specimens, were found variable groups of larger pores, identical in appearance with the pores on the legs. Other smaller pores of the type a were scattered over the rest of the surface. On the dorsal side of the mandibles are found a large number of these same small pores, but in with these are distributed a few of type d, very short peg-like hairs such as have already been described on the legs. The number of the different types is

variable. Group 5 on the dorsal surface of the right mandibles varies from 10 to 16, with an average of 14. The pegs vary from 2 to 8 with an average of 5. Group 5 on the dorsal surface of the left mandibles varies from 5 to 10 pores, with an average of 7. The pegs vary from 5 to 9 with an average of 6. At first it seems strange that there should be such a wide variation between corresponding parts, but it does not seem quite so strange when it is seen that in no case is one mandible the mirror image of the opposite mandible of the same animal. In termites of different species the mandibles of the same animal are often quite different from each other.

Group 6 on the ventral side of the right mandibles varies from 10 to 15 with 13 as an average. On one of the mandibles there were 15 present but 10 were apparently pores of type b, and 5 were of the smaller variety. On the ventral side of the mandibles these two types were seen more often. The large pores varied from 5 to 9, 7 on the average, and of the small pores there were usually 8 or 9. No peg-like hairs were ever seen on the ventral sides.

When the microscope was focused down on these pores, their passage through the thick chitin to the very interior could be clearly observed.

Maxillæ and Maxillary Palps.

(Plate XX, Figs. 18 and 19).

The only true Hicks pores on the maxillæ are found in groups of three (Group 7) on the palps at the ventral distal portion of the second segment. Occasionally Hicks pores may be found isolated on other parts of the maxillæ but these are never constant.

Group 7a on the ventral side of the galea, consists of 9 to 12 very minute pores or pegs. The elevations of these are so small that they are seen only with the most careful observation. On some, the tiny raised hairs could not be seen at all, and it may be that this group is a mixture of the pores of type a and the small pegs of type d. On the dorsal side of the galea are found small pegs. These are a little longer than the ones on the ventral side and there are not as many of them.

At the base of each maxilla on the ventral side, there are found two groups of pegs (Groups c_6 and c_7). Group c_6 is more proximal than Group c_7 and they are also very slightly longer.

Pegs are found in definite small groups c_1, c_2, c_3, c_4, and c_5, at the articulations of the segments of the palpi. These are seen from the dorsal side. They are short, very slender pointed hairs of type d, exactly the same as those described on the legs and at the bases of the antennæ.

On each segment of the palpi there are small round pores of the type a, such as are found on the antennæ, but they are not definitely located.

Labium and Labial Palps.

(Plate XX, Figs. 20 and 21).

Group 8 consists of a definite row of the pores of type a, which are situated on the dorsal side of the galea of the labium, this being really the floor of the mouth. This row of pores extends from the very distal tip end to the base where the labium articulates with the head proper. Group 9 is composed of similar pores on the ventral side, but these are not in any such definite arrangement, being scattered over the length of the galea. On the ventral side of the lacinia are a few scattered small pores and pegs.

Groups d_1, d_2, and d_3, consist of small pegs of the type d such as were present in similar groups on the legs, the maxillary palps, and at the bases of the antennæ. On the labial palps they are found at the bases of each segment near the regions of articulation, just as on the maxillary palps. Each group is composed of six or seven pegs.

Hypopharynx.

(Plate XX, Figs. 16 and 17).

The dorsal surface of the hypopharynx is covered with hairs which lie very flat and are arranged in two longitudinal rows with the hairs directed toward the midline. At the basal part they are in a rosette formation. The ventral surface is comprised of similar hairs arranged as indicated in Figure 17. On either side of the midline near the articulation are four true Hicks pores, Group 11. None of the pores of type c such as were seen on the labrum, were observed on the hypopharynx.

External Structure.

Pores of type b, such as are most numerous on the legs of the termites, are the true Hicks vesicles. They have a definite

shape and would never be confused with the pores of type a on the antennæ, or with the bases of hairs. They are almond shaped, elongated and pointed at opposite ends. The greater part of the external surface is flat but there is a narrow darker boundary encircling the edge. This appearance may be due to the internal structure of the flask. The manner in which the sides of the flask curve makes a greater thickness of chitin at the edges through which the light must pass when examined under the microscope. On the legs of the soldiers the pores seem to have slight elevations. It may be that the "chitinous cones" do not fit closely against the base of the flask. The pores on the antennæ are elongated to a small degree but would never be confused with the true Hicks pores because of their smaller size. Most of the pores on the mandibles, maxillæ, labium, etc., are quite round and very small, though on some mandibles, on the ventral side were seen pores more nearly resembling the true Hicks vesicles. External apertures were not observed on any of the pores though it cannot be said that they are never present. It is possible that the nerve fills the aperture so that, externally, any such opening could not be noticed.

Internal Structure.

(Plate XX, Figs. 22–24).

As in many other insects whose pores have been studied, the Hicks vesicles are small "inverted flask-like structures," the base of the flask being the chitinous layer. If a pore aperture is present, it would be in the center of this layer. At the bottom of the flask, as in the pores of most insects, is a closely fitting plug of chitin which McIndoo calls a "chitinous cone." In the sections fixed in Vom Rath's fluid, a sensory fiber could be traced to this "chitinous cone," but in no sections could it be seen to perforate it. This is not to be wondered at, however, for the pores are extremely minute. In order to determine exactly all points regarding the internal structure of these pores, a great many slides would have to be made before one could be found which would pass through the pore aperture if such were present. In the works of several German investigators to which Frisch refers, no apertures were represented and Frisch is inclined to disregard the statements of McIndoo on this point. How odors can pass through the chitin without some such arrangement is difficult to comprehend. Experiment is surely

a much sounder basis for determining the location of any sense than a morphological study ever could be.

Structures on Soldiers and Winged Forms.

There is really very little to be said regarding the location and the numbers of the various groups of pores and pegs on these two castes because, in general, they possess the same groups with only the slightest variation in the numbers within the groups. Consequently, only the outstanding differences will be mentioned.

There is one noticeable difference in the external appearance of the pores on the trochanters of the soldiers from those on the workers. They have a definite elevation which was found to be due to the presence of a sort of raised hood-like membrane. It was quite impossible to tell even under the highest power, whether each of these pores had an external opening or not. The spot in the center of each one might easily have been the ending of the nerve inside, or the hollow internal area of the flask.

Stokes, in his paper, states that the pores of the subgroups of Group 1 are of different structures, the ones in the center being "conical, often oblique, hood-like structures" while the group of four at the side resemble "flat-topped papillæ pierced with a central depression above the membrane." In all the termites examined for this study, no such difference has been noted. All the pores on the trochanters of the legs are the same, except that in the soldiers the membrane over the top of each pore is elevated to a greater extent than in the workers.

Since the mandibles of the soldiers are quite different from those of the workers or the winged forms, a special examination was made. There was found to be just as great a variation in the number of the pores and pegs, and in their disposition, as on the mandibles of the workers. They are scattered about over the dorsal and ventral surfaces in quite a haphazard way. There may be three to five groups. It is really hardly safe to call them groups. However, the same thing is true here as in the case of the worker, namely, that while pores and pegs are interspersed with each other on the dorsal side, there are never any pegs on the ventral side.

On the maxillæ of the soldiers, on the ventral side at the basal part, are many minute pegs and in among them, in one case, were seen two true Hicks pores.

The wings of the winged caste were examined for the purpose of discovering whether or not groups of pores were present near their bases as have been described by Hicks and McIndoo in so many other insects. At most, there were only a few scattered pores, the bases of the wings being covered with many hairs. There was no indication of any such definitely arranged pore groups as those seen, for instance, by McIndoo on the ants, bees, and flies.

Experiments.

Review of Previous Work.

McIndoo has studied in detail, the structure of the pores which were first described by Hicks. He finds organs on the antennæ of bees which externally appear much the same as the pores on the legs and wings. These he calls "pore plates." A study of the internal structure of the "pore plates" shows that if they are olfactory in function, the odors must pass either a thin or a thick layer of chitin in order to reach and stimulate sensory nerve fiber. Some authors have attributed an olfactory function to these organs in spite of their structure, by assuming that odors can pass through the hard chitin in insects where it would be impossible in higher animals.

The "olfactory pores" on the legs and wings, he finds much more adapted for service as olfactory organs because, as he says, the nerve fibers run to the external surface where they can be stimulated by odors without it being necessary for the odors to pass through the hard chitin. This is one of McIndoo's arguments for his conclusion that the olfactory sense in insects is located on the legs and wings and not on the antennæ.

Frisch disagrees with McIndoo as to the structure of these pores. He says that anyone who is acquainted with their morphological structure as described by Leydig (1860), Kraepelin (1883), Weinland (1891), Rohler (1906), Vogel (1911), Hochreuther (1912), or Deegener (1912), could believe that the pores on the legs and wings are better adapted for an olfactory function than those on the antennæ. He does not agree with McIndoo's assertion that in the "olfactory pores" (vesicles of Hicks), the chitin is perforated by the nerve ending and so comes into direct contact with the air. Frisch emphasizes the fact that the only way to be at all sure what organs are olfactory, is

by new experimental methods, since we know nothing concerning the permeability or impermeability of the chitinous membranes to olfactory particles.

While McIndoo lays much stress upon the morphological structure of the pores, he has tried to uphold his views with a series of detailed experiments. Heretofore, most of the investigators in this field, had paid no attention to the normal behavior of their insects. They cut off a few joints of each antenna, the whole of both antennæ, or varnished them with shellac, paraffin, vaseline, and other substances. Then when the reactions of the insects were weakened or discontinued entirely, it was unhesitatingly concluded that the organs for the perceptions of odors were located on the antennæ. It is quite natural that they should reach such a conclusion because most of the insects thus mutilated have failed to respond to odors held near them to which they would ordinarily have reacted. They have failed to find food, and when removed from food they have accidentally come across, have failed to return to it. Males so mutilated do not usually seek females and take no notice of females placed near them.

McIndoo criticizes all these former experiments, saying that the men have left out of consideration the normal behavior, and that they have disregarded the effect upon the insects, of the mutilations. Miss Field (1901) is the only one who has kept any record of the effect of the mutilations upon the normal lives of her insects. According to her, only 40% of her mutilated ants recovered from the shock, and, in all probability, she says, none of these were absolutely normal. McIndoo has kept records of the effects of such operations upon the behavior and length of life of his animals. He claims that cutting the antennæ injures the insect to such an extent as to make it impossible for the animal to respond to odor stimuli. Exposing the large sense cells to the air would, in itself, cause abnormality. Furthermore, his records seem to show that such mutilations shorten the lives of the insects. He admits, however, that as long as they do live, they appear to be perfectly normal, except in their failure to recognize odors.

McIndoo's first experiments were performed upon normal bees. As odor stimuli he used the essential oils of peppermint, thyme, and wintergreen, bee foods, such as honey, honey comb, and pollen, parts of plants such as honeysuckle flowers, penny-

royal, spearmint, and scarlet sage, and also bee stings. His conclusion from these experiments is merely that bees possess an acute sense of smell.

Having become thoroughly acquainted with the reactions of normal bees, McIndoo proceeded to experiment upon mutilated ones. When one or both antennæ are removed, they apparently recover from the shock and seem normal, but they do not live as long as the unmutilated ones. But since they are shorter-lived they must be abnormal and consequently he believes that any results obtained from experiments upon them cannot be regarded as valuable. Bees having both antennæ pulled off or covered with celloidin, failed to respond to the essential oils. When both the antennæ were burned off, seven of the bees thus treated, recovered sufficiently to eat, though they were far from being normal. They readily responded to the essential oils, the reaction time being not quite twice that of normal bees.

From these experiments McIndoo draws his conclusions. Whenever the antennæ are mutilated in any way, the insects are never normal. Since they are abnormal, if they fail to respond to odors it can be laid to the effect of the operation. Moreover, since seven bees recovered to a slight degree and did respond, the olfactory organs must be located elsewhere than on the antennæ.

Animals having their maxillæ or labial palps removed reacted normally, though they did not live as long as unmutilated ones. The same was true when the proboscides or mandibles were cut away. McIndoo, therefore, does not believe that the olfactory organs are located on the mouth parts. Considering that the pores described by Hicks on the legs and wings are conveniently situated and are so evidently adapted morphologically for the reception of some kind of chemical stimulus, he decided to test them for what seemed the most probable, that of odor.

When the wings of the middle aged bees were removed, the reaction time was increased eight times. When the pores on the legs were covered, the time of response was increased twelve times. Since these animals were entirely normal in their behavior and length of life, this increase in reaction time could not be laid to abnormality and therefore McIndoo's conclusion is that these pore-like organs are to some degree

concerned with the sense of smell. By similar experiments upon beetles and ants he reaches the same conclusions.

Exactly opposite conclusions as to the location of the olfactory sense in insects, at least in the bee, have been reached as the result of the more recent experimental work carried on by Karl V. Frisch. Frisch is extremely skeptical regarding the conclusions held forth by McIndoo. As stated above, he does not believe that the pores on the legs or wings are any better adapted for receiving odor stimuli than the "pore plates" on the antennæ. McIndoo considers them superior because the nerve endings perforate the chitin and are exposed to the air. Frisch does not admit the presence of any such apertures. He does not think it wise to base conclusions as to the location of any sense upon ground less firm than that of experiment. He therefore looks to new experimental methods to solve the problem. The new method adopted by him for this purpose is one in which all the bees used in the olfactory experiments are first trained to recognize certain odors. Instead of using the irritating essential oils, he employed such odors as esteric oils, flowers, etc. He saturated the food of the bees with some odor and then trained the bees to come to it regularly. He used several square glass jars or boxes and in one only the fragrant food was placed. The bees came to this box invariably for their food. To this one jar was fastened a feeding trough which became automatically filled when the bees entered it. During the experiment the feeding trough was taken from the scent box, placed on top, and the box removed to a new location. The bees flew about for some time until one bee noticed the change. As soon as it drank it was marked on the thorax and placed with the trough into the box. The bee soon departed, but learned to return to the new place, bringing other bees which were also marked. During this experiment, the box containing the odor was often changed about from one place to another and boxes identical in appearance but containing no odorous substance within, were substituted. After the bees were sufficiently trained so that they never failed to find the odor, their antennæ were cut off. Immediately they were unable to locate the scent box. Of eighteen experiments none failed. Covering the antennæ with oil, paraffin, or shellac gave poor results.

Frisch carefully controlled all his experiments with color experiments. He used, for this purpose, boxes of exactly the same size and shape, but of different colors. The bees were trained to come to one box. When the antennæ were cut, they were in no way hindered from finding the colored box. In this case the bee is controlled by sight, while in the former experiments by smell.

When a single antenna was removed, there was found to be practically no effect upon the ability of the bees to find their food. When a few segments of each antenna were removed the bees showed plainly that they recognized odors. If eight distal segments of the twelve which make up antennæ were cut off, the bees acted as though they had no antennæ at all. No olfactory organs are then located upon the three basal segments. If the antennæ were cut so that on one side four segments remain, and on the other side only three, even then the bees were able to recognize the odor. Moreover, a bee in which only five segments of one side remained, could still be trained to recognize a new odor. The only conclusions to be drawn from these experiments is that made by Frisch, that the olfactory sense is located upon the antennæ in bees, and not elsewhere.

Because McIndoo lays so much emphasis upon the effect of the injury of cutting the antennæ upon the normal behavior of insects, Frisch has performed experiments to test its truth. It is generally accepted that male moths are attracted to females by the olfactory sense. After the antennæ were amputated, the males were no longer able to find the females. In some cases the males were deprived of their legs, in others the wings. Such males could not be prevented from finding the females.

Forel, in working upon ants, has found that if the antennæ are cut off, they do not recognize their enemies, but if their legs are cut off, they do. Furthermore, it is a well known fact, according to Frisch, that many important organs, such as the legs, eyes, wings, parts of the head, etc., may be cut without injuring in any way the use of the antennæ.

Methods.

The termites upon which the experiments were performed were found under rocks and old logs in the woods near New

Haven, Conn. For each experiment, a single termite was removed from the main dish and placed by itself in a Syracuse dish which had a piece of black paper pasted on the bottom. The animal was unable to climb over the edge of the dish, and against the black background, could be observed with ease. Both workers and soldiers were experimented upon, but the best results were obtained from experiments upon the soldiers, for these react more definitely to odor stimuli. The large black Camponotus ants were used as controls, since these are known to possess a keen sense of smell, while that of the termite has not heretofore been described in any detail.

Experiments were made in which one or both antennæ were carefully cut off at their bases with iridectomy scissors. Most of the experiments, however, were performed by the application of *local* anaesthetics either to both the antennæ or to the legs. For an anaesthetic, a 1% solution of cocaine hydrochloride was found to give to most satisfactory results. One per cent solution of chloral hydrate and of chloretone were also tried, but they required a longer time in which to become effective and were finally abandoned in favor of the cocaine hydrochloride solution. The anaesthetic was applied with the aid of a fine paint brush. It was somewhat difficult to cover the antennæ without touching other parts of the insect because of their constant activity, but after the first few attempts no trouble was experienced. The antennæ could be caught and held by the moistened brush, and when the brush was removed the drop of the solution remained on the bottom of the dish with the antenna held in it. In this way it was made sure that all parts of the antennæ were equally bathed. In order to be certain that enough of the anaesthetic was applied, the antennæ were treated twice and often three times. The method used in covering the legs was to place a large drop of the anaesthetic between the insect and the metal prong of a pair of forceps upon which the termite had been made to climb. Caught and held in this manner for as long a time as was deemed necessary for the substance to act, the termite was then released. The head of the insect was always held up in the struggle for freedom and so none of the solution ever came in contact with the antennæ. If care was exercised not to put too much of the anaesthetic on, the paralysis would occur in a short time, usually not longer than ten or fifteen minutes, and would wear

off after an hour or two. That the sense organs were actually functionless could be determined by touching the appendages with a needle or forceps. Normal animals react immediately but these partially anaesthetized animals take no notice of such stimulation. Then, too, the effect of the anaesthetic could be seen very often by the difficulty with which the insect walked.

Several different types of odors were used, such as the essential oils of thyme and wintergreen, clove oil, cedar oil, chocolate, onion, beef extract, and a piece of a freshly killed termite. In bringing the odors to the termites, the eye ends of needles dipped in the oils were used. Each odorous substance had to be held within two millimeters of the head of the termite unless the animal was absolutely quiet, a rare occurrence. At least five minutes were allowed to elapse between experiments.

No attempt has been made to keep track of reaction times or to keep detailed records of the type of reactions of a large number of animals, as McIndoo has done, for such experimental work requires a much longer time than could be given. The experiments were meant only to show the presence of an olfactory sense, to find out in a simple way, as far as possible, its probable location, and to try out the method of local anaesthesia, which has never been used to any extent and which if successful, overcomes the point which McIndoo stresses concerning the effect of the shock of the amputation of the antennæ upon the reactions of the animals.

Experiments Upon Termites.

The fact that these insects live underground and feed mainly upon the cellulose of living or dead vegetation, made the choice of odors with which to test them, a somewhat difficult proposition. As in McIndoo's experiments, two of the essential oils, wintergreen and thyme were used, as well as the other oils of cedar and clove. Such substances as chocolate, onion, and beef extract were tried for variety. Onion failed to call forth any response whatever from any of the termites. Chocolate caused a response in one case. Beef extract was "noticed" by one or two of the insects, while the rest paid no more attention to it than if it were some slight obstacle in their pathway. A piece of the body of a freshly killed termite worker gave the best results of any of the odors aside from the oils.

a. Reactions of Normal Termites.

In order to make sure that the insects would not react to any object placed near them, odorous or otherwise, the termites were tested with clean needles or forceps. In most experiments of this sort, no notice of its presence was taken unless the insect perchance happened to bump into it or came into contact with it by accident. In these cases there were immediate reactions due to the tactile stimulations. The workers backed away hastily or stopped, feeling with their antennæ, only to go on again either directly over it or to one side. Occasionally the soldiers would fight it, though most often they would pass by unconcernedly. In a few cases, however, the termites did seem to feel its presence and backed away, as Stokes remarks in his paper. In these instances it was really very difficult to tell whether they backed because of some unknown factor connected with the approach of the object or whether they would have backed anyway in their constant activity. If they did actually feel its approach, there would still be no difficulty in distinguishing their reactions from those due to olfactory stimuli which are much more energetic. The termites which gave the best reactions to odor stimuli paid no attention to these needles.

The reactions of normal termites to the oils of thyme, wintergreen, cedar and clove, were practically the same. All were instantaneous. If the insect was running about the dish as was usually the case, and the needle dipped in the oil was placed two millimeters directly in front, the animal stopped immediately, backed three or four millimeters, and proceeded ahead at another angle. In some cases the reactions with the wintergreen were not quite as speedy as those with the thyme, though with most no difference would be noticed.

The normal workers were not stimulated by chocolate, onion, or beef extract. Only one paid any attention to a piece of a termite body. This one responded only to the extent of waving the antennæ in its direction for a moment, immediately hastening on. Consequently the odor reactions of the workers can only be interpreted by their responses to the oils.

Soldiers, however, were much more satisfactory in their behavior. Their reactions to the oils were the same as those of the workers. They gave no response to onion. Two soldiers

stopped and proceeded in another direction when beef extract was placed near, but this may have been due to some cause other than odor. One soldier only, seemed to respond to the chocolate. This animal, however, was the one which gave by far the best reactions to all odors. This experiment will be discussed in detail later.

(*b*). *Reactions of Termites with Antennæ Removed.*

1. With one or both antennæ cut off.

(a) One antenna of a termite worker was cut off at the base and the animal set aside so that the effect of the operation could be observed. In all respects, the termite appeared to remain normal and did not seem to be at all upset by the mutilation. Its activity was in no way slackened.

(b) When both the antennæ of another termite worker were cut the immediate effect was striking. The animal which had been very active even with one antenna gone, stopped immediately and acted dazed. It found considerable difficulty in walking and its whole body shook spasmodically. Later on, the animal seemed to become more normal though never entirely so.

(c) On another day, three termite workers were removed from the main dish and put into a Syracuse dish. One antenna was cut from one, and both from another, leaving the third as a control. When observed again in two days, they all appeared normal and were tested with a clean needle, oil of thyme and oil of wintergreen. No notice was taken of the clean needle by any of the three. Upon the approach of the wintergreen, the normal termite immediately backed away. The second termite, lacking one antenna, gave a very good though slightly slower reaction. The third termite lacking both antennæ, seemed to notice the odor, but it did not turn away. It merely stopped and worked its mouth parts. The same reactions occurred in each case when the oil of thyme was used. These experiments would indicate that these two essential oils do in some way stimulate the termites in the absence of their antennæ though not as forcibly. Whether they should be called olfactory stimuli is uncertain. Such oils are known to be irritating to the respiratory system as well as to the olfactory organs.

(d) A worker having both antennæ removed and appearing perfectly normal and active, was tested with clove oil. The

animal reacted when the needle was held directly in front. When the needle was moved to the side there was no response whatsoever. This would seem to suggest that the mouth-parts are somewhat sensitive to such stimuli, but this would be natural with irritating oils.

The experiments on termites having their antennæ cut were not as clear as those made on animals whose antennæ were anaesthetized. Such experiments were made only for comparison and because former investigators used this method.

(*c*). *Experiments Using Anaesthetics.*

1. Antennæ treated with chloretone.

(a) Both antennæ of a termite worker were carefully covered with a solution of chloretone, and in an hour and a half the termite acted perfectly normal. There was no response to either thyme or wintergreen. Fifteen minutes later the two oils were again brought near the same animal and there was still no reaction. Even when the antennæ were touched with the needle which had thyme on it, there was no reaction, showing that the antennæ were thoroughly paralyzed.

2. Antennæ treated with chloral hydrate.

(a) Chloral hydrate could not be made to affect the antennæ as thoroughly as the chloretone or the cocaine hydrochloride. Chloral hydrate was applied to the antennæ of a worker and when tested later, the animal reacted to both thyme and wintergreen. More of the anaesthetic was used, but with the same results. When chloral hydrate was placed on the legs, the reaction was equally pronounced.

3. Antennæ or legs treated with cocaine hydrochloride.

(a) In this first experiment the antennæ of a termite worker were twice covered with the cocaine solution. Five minutes after the second application the animal was tested with oil of thyme but showed no response.

(b) The antennæ of a second termite worker were treated with cocaine. Immediately afterwards the animal gave instant reactions to both thyme and wintergreen. Later, when the anaesthetic had had a chance to work and the insect was quieter, it was again tested with thyme. While the oil was held in front of the head there was no reaction, but when it was moved to the side the insect's body swayed away from it.

Five minutes later the same test was repeated and with exactly the same result. The termite acted distinctly irritated, its whole body shaking at intervals. A third test gave the same result. When tested with the oil of wintergreen held in front of the head, no reaction of any sort was apparent. When transferred to the left side, the whole body straightened and the posterior part of the abdomen turned upwards. Such a reaction can hardly be interpreted as anything but an evidence of irritation.

(c) Cocaine was applied to both the antennæ and the legs of a worker. As soon as all the appendages ceased to be sensitive to the touch, the termite was tested with thyme but with no response.

(d) The antennæ of a termite worker were covered with cocaine. They became bent and were directed to each side instead of forward as normally. The animal mouthed them several times. In five minutes there was no reaction to clove oil. Five minutes after this first test, oil of thyme was brought near and there was a slight response. About four hours later the animal was again tested with clove oil but with no reaction.

(e) Once again the antennæ of a worker were treated with cocaine which was applied five times. After an hour the insect became quiet, though it was very ferocious when touched. The antennæ were found to be thoroughly anaesthetized. Upon testing with the thyme in front of the head there was no reaction but when the needle was placed at one side, the termite in a few moments lifted a leg and moved the whole body as if irritated.

(f) Experiments f and g are the most conclusive which have been made and are the ones most to be depended upon. Soldiers were used in both, and since in experiment g the normal soldiers reacted to other odors as well as to the essential oils, the partially anaesthetized ones could be tested with these true odors which are better criteria.

In this experiment two soldiers were placed in separate Syracuse dishes, and their normal reactions to all odors were recorded.

TABLE I.

	1	2
Heat	Animal still throughout; Noticed but did not avoid.	Backed
Wintergreen	Backed	Backed
Thyme	Backed	Backed
Clove Oil	Started back, then jumped at it and bit it	Backed
Chocolate	No response	No response
Onion	No response	No response
Beef extract	No response	No response
Piece of freshly killed termite	No response	No response

After these tests the antennæ of termite (1) were covered with cocaine. When thyme was held in front of the head there was no evidence of any response. When the needle was moved to the side, the termite after a short time raised the legs on that side and the whole body shook. This reaction seemed, as in several previous experiments, to be due to the irritating effect of the oil.

The legs of the second termite were treated with cocaine, the antennæ remaining normal. When tested with thyme the antennæ moved, but there was no backward motion, as in the tests on the normal termites. This was undoubtedly due to the paralysis of the legs.

(g) In this experiment three soldiers were tested, first, for normal reactions, and later, after treatment with cocaine. The first termite of this group gave the most conclusive reactions which have been obtained mainly because it remained quiet throughout the entire experiment.

Termite (1) was the only one in all the experiments which reacted to the odor of chocolate, but the reaction was so clear that it is worthy of a detailed description, especially since this termite gave better responses for all odors than any of the others tested. The piece of chocolate was held near the head of the animal. The antennæ were immediately waved toward it and the insect bit at it furiously. The chocolate was then

TABLE II.

Normal Soldiers	1	2	3
Clean glass rod	No response	No response	No response
Thyme	Instant backing	Instant backing	Instant backing
Wintergreen	Backed	Backed	Backed
Clove oil	Backed	Backed	Backed
Cedar oil	Waved ant. jumped back, snapped mandibles	Backed	Backed
Onion	No response	No response	No response
Chocolate	Good reaction	No reaction	No reaction
Beef extract	Stopped and went in another direction	No reaction	Same as (1)
Freshly killed termite body	Good reaction	Fair reaction	No reaction

moved to the other side of the head and the insect moved its antennæ to that side following the chocolate, again attempting to bite it. When the chocolate was held above, the head was raised and the antennæ waved about.

The reaction of the termite to the piece of the body of the worker was equally interesting. Recognition took place immediately and the animal went around the body twice. By constantly moving the forceps which held it, the termite could be made to follow across the dish. If it was moved at a greater distance than two or three millimeters, the termite lost the odor and went off in another direction. When held above, the soldier raised its head and waved its antennæ. This is the first experiment in which a termite reacted to any odors other than the oils.

After the antennæ were anaesthetized so that they did not respond to the touch and the animal was quiet again, thyme was brought near the head. There was no reaction for 15 seconds. Then the antennæ moved very slightly and the termite started to move ahead. As the thyme was moved to the side the termite moved faster, and when removed altogether, the animal became quiet once more.

With cedar oil, the reaction time was somewhat longer. The soldier tipped its head to the right and lifted the legs on the right side.

With wintergreen, the reaction time was the same as with thyme, only the termite did not start to walk ahead, but only worked its mouth-parts and its legs.

When tested with clove oil, there was a slight reaction seen in the twitching and lifting of the legs on the right side. No working of the mouth-parts took place. When the oil was moved to the right side, the irritation of the legs on that side was emphasized. When transferred to the left side, the legs on that side were raised.

On the other hand, to beef extract, chocolate, and the termite body there were absolutely no responses, though each substance was held on all sides of the insect for a considerable length of time. At the end of the experiment the antennæ were not sensitive to the touch, while the legs were highly so.

The legs of the second soldier of this group were covered with cocaine. After a period of an hour, though the termite had great difficulty in walking, the legs were still slightly sensitive to the touch. There was an immediate reaction to thyme. When tested with the termite body, the soldier followed it as best it could and snapped at it twice. Cocaine was applied four times but the legs continued to remain somewhat sensitive to the touch, though by no means as sensitive as the antennæ which had not been treated. The legs must have been very nearly paralyzed because the termite could hardly walk. Nevertheless, with thyme there was an instant reaction and the response to the termite body was good.

This experiment seems to show that while the legs may remain sensitive to strong irritants, the antennæ alone are the real organs for the distinguishing of odors.

Experiments on Ants.

In order to be certain that the cocaine method is truly reliable, experiments were made upon two large Camponotus ants which are known to have a keen sense of smell. Before applying the anaesthetic, both ants were tested with thyme to which there were instant reactions. The ants bent their abdomens underneath and stroked their antennæ with their fore legs and with their mouth-parts for a space of three

minutes. When tested with wintergreen an equally swift response occurred. During each test the antennæ waved about as though stimulated by the oil. The reaction to the cedar oil was distinct though less violent. Onion, chocolate, and beef extract caused no reactions.

Cocaine was applied to the antennæ of one of the ants. After the antennæ ceased to be sensitive to the touch, the ant was tested with thyme. There was no reaction other than a slight lifting of the legs, such as occurred with the termites. There was no attempt to escape. The thyme was tried several times afterwards, but with no reaction whatsoever. The ant mouthed its antennæ a great deal. Two hours later, the paralysis brought on by the cocaine had passed and the ant reacted normally. This experiment shows that this method is one which can be used for such work to good advantage since it does not cause any injury to the animal yet renders the organ functionless.

Discussion.

When the antennæ of bees are removed by cutting, the insects in almost all cases do not respond to odor stimuli. They appear to behave normally, the only abnormalities being their shortened lifetime and their failure to be stimulated by odors. McIndoo lays all the weight of his argument regarding their failure to respond, upon the injury brought about by the operation. Then when *seven* workers having their antennæ removed, did respond to the three essential oils, after a long reaction period, he concludes that the legs have an olfactory function, regardless of the fact that the odors used were irritating ones. With bees deprived of their antennæ he records no reactions to the stimulation of the true odors such as honey, pollen and flowers. It is hardly fair to draw definite and decisive conclusions from the reactions to the oils. In McIndoo's experiments upon ants, the same criticism may be made. The normal ants were tested with the three essential oils and in addition with the true odors such as honey, combs, pennyroyal, and formic acid, while the mutilated ones were tested only with the three essential oils.

In many of his experiments upon beetles, the insects which had had their antennæ removed were tested only with the three essential oils to which they would naturally respond,

as did the termites, from irritation. When the elytra, wings, and legs were made functionless, the beetles were tested with all the odors and they reacted, though at a much slower rate than normally. Many failed to respond. However, since the animals did respond in some instances, and to true odors, why is it not an indication of the presence of receptors of olfactory stimuli elsewhere—perhaps on the mouth-parts or the antennæ? Yet McIndoo emphatically states that the antennæ have no olfactory function.

When bees' wings are pulled off and their legs covered, the animals respond to the oils and the other true odors, but at a much slower rate. The fact that they do respond, however, seems to indicate that the olfactory sense is not confined to the legs and wings.

Frisch uses only such odors as essence of tube roses or honey. He trains his bees to respond to certain definite odors. Whatever reactions take place after the removal of the antennæ must therefore be quite conclusive in indicating their function as olfactory organs. McIndoo would say that the insects are made abnormal by the operation, yet he himself says that the insects appear perfectly normal in spite of their shortened lives. Since they seem normal, it is reasonable to suppose that their sense of smell would not be interfered with even if they do not live as long. If they were very abnormal, a bee having one entire antenna cut off and all but two segments bearing olfactory organs removed from the other, could never be trained to respond to a new odor.

McIndoo claims that the more segments of the antennæ there are removed the more abnormal the animal becomes. If the abnormality is produced by the severing of certain large sense cells exposing them to the air, why should one cut cause more abnormality than another, that is, if the cells are present the full length of the antennæ? The increase in the abnormality could be more naturally interpreted as being due to the destruction of a greater number of sensory organs, without the use of which the animal becomes abnormal.

McIndoo's description of the pores of the various orders of insects is very accurate and clear, but too much emphasis ought not to be placed upon the structure of any organs when trying to locate a certain sense. It is more reasonable to first locate the sense by careful experiment, as did Frisch, and then

if possible, determine the relation of the organs of that region to that sense.

It would be exceedingly difficult to attempt to correlate the average results of the experiments upon the termites with the anatomy and distribution of the Hicks pores. In the first place, all of these experiments are superficial, and the results are varied. At most they can serve only as a starting point for further systematic investigation. The experiments are sufficient to show, however, that termites do possess an olfactory sense even though it is not very well developed. The average results indicate that the antennæ are distinctly concerned with that sense, since rendering them functionless causes no response to true odors and only the responses to the oils are ones which show irritation. The pores on the antennæ are those of type a and they are few in number, there being but two on each segment and one or two extra ones near the base. Judging from their external appearance, similar pores are present in many places on the mouth-parts. None of these pores are ever found on the legs. None of the Hicks pores were observed on the antennæ. Pores of both types are usually present on some of the mouth-parts. It may be that the pores on the legs are sensitive to chemical stimuli even though not to strictly olfactory ones. The irritated reactions of the termites having their antennæ anaesthetized, when tested with the essential oils, may have been due to the stimulation of these pores, or even to the effect upon the tracheal system.

Though no incontrovertible conclusions can be drawn from the experiments, they promise more conclusive results if similar experiments are carried on in a larger scale. The method of applying local anaesthetics eliminates the difficulties encountered through the injury caused by the operations.

BIBLIOGRAPHY.

Banks, Nathan. 1920. A revision of the nearctic termites, with notes on biology and geographic distribution by Thomas E. Snyder, (large bibliography). Smithson. Inst., U. S. Nat. Mus. Bull., 108.

Basch, S. 1865. Untersuchungen über das Skelett und die Muskeln des Kopfes von Termes Flavipes (Kollar). Jour. wiss. Zool., Vol. 15, pp. 56–75.

Field, A. M. 1901. Further study of an ant. Proc. Acad. Nat. Sci., Phila., Vol. 53, pp. 521–544.

Frisch, Karl v. 1921. Uber den Sitz des Geruchsinnes bei Insecten. Zool. Jahr., Vol. 38, pp. 449–516.

Hegh, E. 1922. Les Termites. (Complete bibliography on termites).

Hicks, J. B. 1857. On a new organ in insects. Jour. Linn. Soc., Zool., Vol. 1, 1859. On a new structure in the antennae of insects. Trans. Linn. Soc. Lond., Vol. 22.

1860. On certain sensory organs in insects, hitherto undescribed. Jour. Linn. Soc. Lond., Vol. 23.

Janet, Charles. 1904. Observations sur les fourmis. Limoges, pp. 17–22.

1911. Organs sensitifs de la mandible de l'abeille. L'Apiculteur, 55e Anne, No. 3 Mars, pp. 107–108.

Kollar, V. 1837. Naturgeschichte der Schädlichen Insekten. Verhandl. Landwirthsch. Gesell. Wien., Vol. 5, n. s., p. 41.

McIndoo, N. E. 1911. The lyriform organs and tactile hairs of Araneads. Proc. Phila. Acad. Nat. Sci., Vol. 63, pp. 375–418.

1914. The olfactory sense of insects. Smithson. Inst., Vol. 63, No. 9.

1914. The olfactory sense of the honey bee. Jour. Exp. Zool., Vol. 16, No. 3, pp. 265–346.

1914. The olfactory sense of Hymenoptera. Proc. Phila. Acad. Nat. Sci., Vol. 66, pp. 294–341.

1915. The olfactory sense of Coleoptera. Biol. Bull., Vol. 28, No. 6, pp. 407–460.

1916. The sense organs on the mouth-parts of the honey bee. Smithson. Inst., Vol. 65, No. 14.

1917. The olfactory sense of Lepidoptera. Jour. Morph., Vol. 29, No. 1, pp. 33–54.

1918. The olfactory organs of Diptera. Jour. Compar. Neurol., Vol. 29, No. 5, pp. 457–484.

Packard, A. S. 1883. Third report, U. S. Entomological Com. Washington. "Termitidae," pp. 326–329.

Stokes, Alfred C. 1893. The sense organs on the legs of our White Ants, Termes flavipes Kollar. Sci., Vol. 22, No. 563, pp. 273–276.

Snyder, T. E. 1913. Changes during quiescent stages in the metamorphosis of Termites. Proc. Ent. Soc. Wash., Vol. 15, No. 4, pp. 162–165.

1919. Some significant modifications in the nearctic Termites. Proc. Ent. Soc. Wash., Vol. 21, No. 5, pp. 97–104.

Thompson, C. B. and **Snyder, T. E.** 1919. The question of the phylogenetic origin of the Termite Castes. Biol. Bull., Vol. 36, No. 2, pp. 115–132.

Thompson, C. B. 1916. The brain and frontal gland of the castes of the White Ant, Leucotermes flavipes Kollar. Jour. Comp. Neur., Vol. 26, No. 5.

1917. Origin of the castes of the common Termite Leucotermes flavipes Kollar. Jour. Morph., Vol. 30, No. 1.

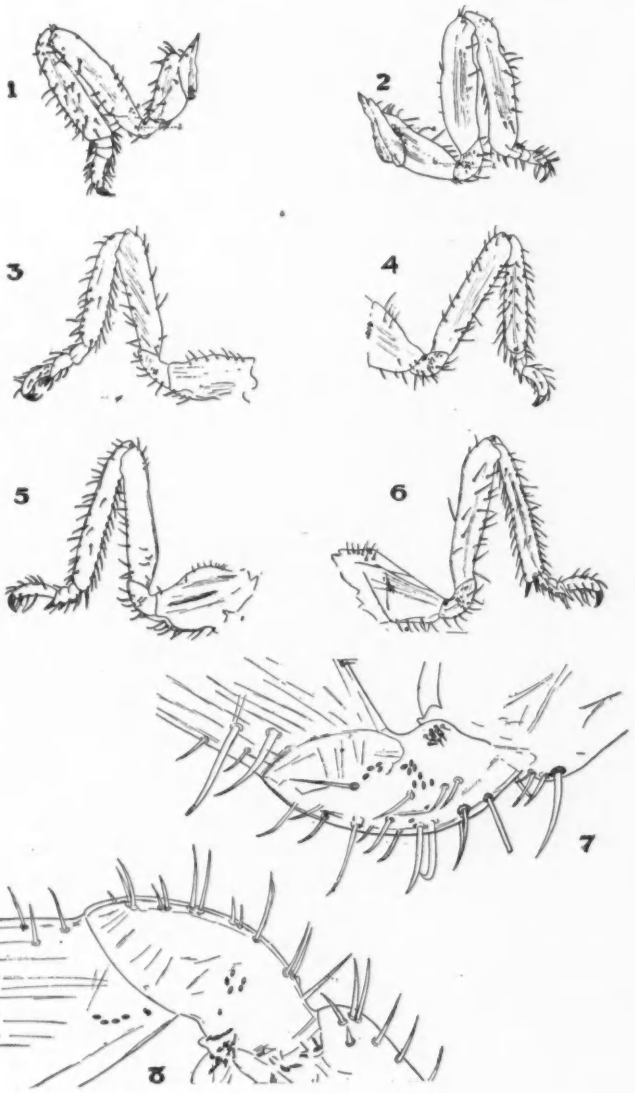
EXPLANATION OF PLATES.

PLATE XIX.

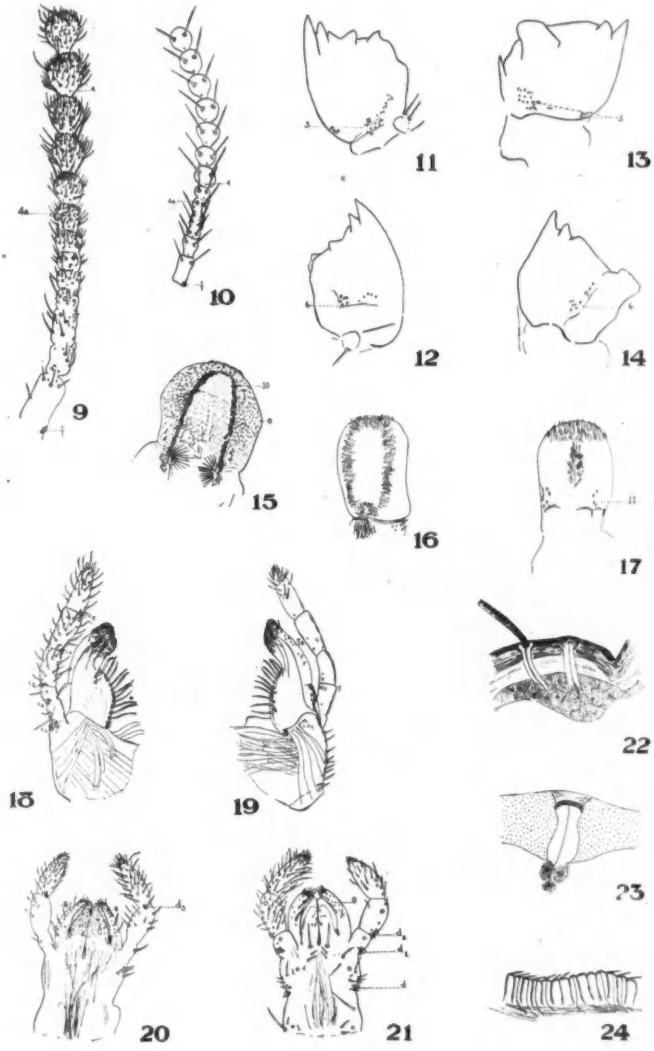
Fig. 1. Left front leg of a termite worker, dorsal view showing location of Groups 2 and 3 (× 37).
Fig. 2. Left front leg of a termite worker, ventral view, showing location of the pores of Group 1, and the pegs of Groups a and b, (× 37).
Fig. 3. Left middle leg of the same worker, dorsal view, (× 37).
Fig. 4. Left middle leg, ventral view, (× 37).
Fig. 5. Left hind leg, dorsal view, (× 37).
Fig. 6. Left hind leg, ventral view, (× 37).
Fig. 7. Trochanter of the right hind leg, ventral view, (greatly magnified).
Fig. 8. Trochanter of the right hind leg, dorsal view, (greatly magnified).

PLATE XX.

Fig. 9. Dorsal view of right antenna of termite worker, (two segments missing), (× 62).
Fig. 10. Ventral view of left antenna of another termite worker, (× 37).
Fig. 11. Dorsal view of the left mandible of a worker showing the irregularity of the arrangement of the pores and pegs which compose Group 5, (× 37).
Fig. 12. Ventral view of the same mandible showing the pores of Group 6, (× 37).
Fig. 13. Dorsal view of the right mandible, (× 37).
Fig. 14. Ventral view of the same right mandible, (× 37).
Fig. 15. Ventral view of the labrum of a termite worker showing the pores of Group 10, (× 37).
Fig. 16. Dorsal view of the hypopharynx of a worker, (× 37).
Fig. 17. Ventral view of hypopharynx, showing the four Hicks pores of Group 11.
Fig. 18. Dorsal view of the left maxilla of a termite worker, showing the Groups of pegs c_1, c_2, c_3, c_4, and c_5, at the basal portion of each segment, (× 37).
Fig. 19. Ventral view of the left maxilla showing the three Hicks pores which comprise Group 7, and the pores and pegs on the galea, Group 7a.
Fig. 20. Dorsal view of the labium and labial palps of a termite worker, showing the definite row of pores on the galea which make up Group 8, (× 37).
Fig. 21. Ventral view of the labium and labial palps showing the scattered pores of Group 9 and the pegs of Groups d_1, d_2, and d_3, (× 37).
Fig. 22. Longitudinal section through a pore on the antenna of a termite worker showing the innervation and general structure.
Fig. 23. Longitudinal section through a Hicks pore on the trochanter of the leg of a termite soldier.
Fig. 24. Longitudinal section through the pores on the labrum of a termite worker, showing the arrangement of the pores, their innervation, and the flat hairs.



Rhoda A. Hartmell



Rhoda A. Hartwell

NOTES ON SOME NEOTROPICAL REDUVIIDÆ.

S. B. Fracker, Madison, Wisconsin,
and
Stephen C. Bruner, Santiago de las Vegas, Cuba.

The authors have recently had occasion to review some collections of Heteroptera from Central and South America, and from Cuba, the Reduviidæ of which form the basis of the present notes.

The South American material was secured from two sources, one collection being made by H. S. Parish, of Toronto, during the winter of 1919–1920, in the Valley of the Amazon and the mountains of Ecuador and Peru; the other from the same general neighborhood, by Mr. G. H. H. Tate, of Pitman Place, Mt. Tabor, New Jersey, in 1921 and 1922.

A small series of specimens was obtained in Honduras during April, 1923, by the junior author, who also collected a large part of the Cuban material, but all of the specimens in the collection of the Cuban Agricultural Experiment Station have been available in preparing these notes. The species recorded from Colon, Cuba, were taken by Dr. Arturo Comas, Director of the Granja Escuela of Matanzas Province; the names of other collectors who have made contributions of especial interest are indicated under each species.

The Cuban material has been compared with the specimens in the Gundlach Museum in Havana, which could not, however, be removed from their glass covered boxes for careful study. The authors are jointly responsible for all new species, but the South American specimens referred to herein as species already described have in some cases not been examined by the junior author and he is therefore not responsible for this part of the material.

SAICINÆ.

Tagalis inornata cubensis McAtee and Malloch, taken from spider webs in the Experiment Station building at Santiago de las Vegas, Cuba (J. Acuna). This species is labeled "Saiccodes annulatus Uhler" (No. 429) in the Gundlach Museum.

Oncerotrachelus acuminatus Say; five specimens collected at Santiago de las Vegas, Cuba, in the same situation as the preceding.

Saica recurvata Fabr., from Teffe, Brazil.

Saica meridionalis n. sp. This species from Brazil is very similar to *tibialis*, differing in the black antennæ and black legs with red knees and in the presence of caudo-lateral spines at the apex of the abdomen of the female.

Description. Elongate, moderately slender; flavo-testaceous, with the first two segments of the antennæ, basal two-thirds of the femora, apical two-thirds of the tibiæ, and tarsi nigro-fuscous; veins of the corium and its prolonged apex, posterior lobe of the pronotum, apex of the femora, base of the tibiæ, spots on the basal segment of the rostrum and on the meso- and meta-thorax laterad of the coxæ, vermillion red; pronotal and scutellar spines partly or entirely fuscous.

Posterior pronotal and scutellar spines long, slender; second antennal segment one-half as long as first. Stiff setæ of anterior femora arranged in fascicles. Fore-wing with three completely closed discal cells; membrane in both sexes, just reaching apex of abdomen; in the female leaving the caudo-lateral angles of the terminal segment uncovered, these angles armed with short, straight, acute spines about as long as the tarsal claws.

In general appearance, size, shape of head, rostrum, legs and pronotal and scutellar spines, this species is very similar to others of the genus. Length, 12–13 mm.; breadth, 2 mm.

Holotype, female, collected at Manaos, Brazil, November 15, 1919, by H. S. Parish.

Allotype, male, collected at Teffe, Brazil, December 23, 1919, by H. S. Parish.

PIRATINÆ.

Rasahus albomaculatus Mayr, from Teffe, Brazil.

Rasahus sulcicollis Serv., from Teffe, Brazil, and Napo River, Peru.

Rasahus biguttatus Say, twenty-one specimens from Chaparra, Camaguey, Colon, Remedios, Havana, and Santiago de las Vegas, Cuba. This species is frequently attracted to lights and its painful bite is well known in Cuba.

Tydides rufus Serv., from Teffe, Brazil.

Sirthenia stria Fabr., from Teffe, Brazil, and Iquitos, Peru.

Melanolestes morio Erichs., two specimens from Colon, Cuba; a new locality record.

Melanolestes picinus Stal, three specimens from Teffe, Brazil.

REDUVIINÆ.

Leogorrus litura Fabr., one specimen from Camaguey (J. Acuna) and five from Nueva Gerona, Isle of Pines, Cuba. The latter were found under the loose bark of a dead pine. The nymphs had covered themselves completely with dry particles of decayed wood.

Spiniger formosus Stal, from Yurimaguas, Peru.

Spiniger limbatus Lep. and Serv., from Teffe, Brazil, and Yurimaguas, Peru.

Meccus flavidus Neiva, five specimens from Gibara (S. del Campo), Oriente Province, and Camaguey (J. Rutz), Cuba. This insect, which feeds normally on the blood of man and other mammals, has so far been taken only in the palm thatched houses of the natives in eastern Cuba, where it is known by the name of *chinchorro*. The females of the species attain a length of slightly over 3 cm. A specimen in the Gundlach Museum is labeled "*Rhodnius prolixus* Stal (No. 88)" a South American species, the occurrence of which in the West Indies seems very doubtful.

Triatoma dimidiata Latr., from Bucay, Ecuador. This and the three following have been convicted of carrying *Trypanosoma cruzi*, the causal agent of Chagas fever.

Triatoma infestans Klug, one specimen obtained from the Oswaldo Cruz Institute of Rio de Janeiro, Brazil.

Triatoma rubrofasciata DeGeer, collected by C. C. Gowdey, at Hill Gardens, Jamaica, November 27, 1922.

Lamus geniculatus Latr., from Teffe, Brazil.

Lamus megistus Burm., two specimens from the Oswaldo Cruz Institute, Rio de Janeiro, Brazil.

VESCIINÆ new subfamily.

This subfamily is proposed for the genus *Vescia* which should not remain in the Reduviinæ (Acanthaspidinæ) where it was placed by Stal, as there are no ocelli, the pronotum is divided behind the middle, and there is a mesal spine between the antennæ, which characters distinguish it completely from that subfamily, although there is a certain similarity to some of the genera in the shape of the head and venation of the hemelytra.

Characters of subfamily: Ocelli absent, basal joint of antennæ short; head armed with spine between antennæ; rostrum normal, unarmed; pronotum constricted caudad of middle, armed with spines; apex of scutellum narrow; anterior coxæ much shorter than femora; tarsi normal; hemelytra without a quadrangular discoidal areole; anal areole of membrane extending farther proximad than costal areole.

The genus *Vescia* has the femora and tibiæ unarmed above, but the anterior pair of each are provided below with a row of small teeth. The anterior femora are also strongly incrassate and the anterior tibiæ have the apex produced into a point behind the tarsus. The lateral angles of the pronotum are armed with a stout spine and there are two smaller spines on the disk near the posterior margin. The lobes of the pronotum are divided by a deep and broad transverse sulcus and the anterior lobe has a narrow longitudinal median groove. The scutellum is armed with a long spine just anterior to the apex. The antennæ are inserted on top of the head. The basal joint of the rostrum extends to the caudal margin of the eyes and is subequal in length to the second; the third is much shorter than the second.

Vescia spicula Stal. This is apparently a common species at Teffe, Brazil, as eighteen specimens, both male and female, were in the collection from Parish. Most of them were collected on January 21,

but a few on December 22. One specimen is from Iquitos, Peru, taken in February. The various specimens measure from 8.5 to 9.5 mm. by 2.5 to 2.7 mm.

Vescia minima n. sp. Three specimens of this genus are so much smaller than the others that they seem to represent a separate species.

Description. Fuscous to castaneous, shining, anterior lobe of pronotum sometimes darker; corium bordered with paler along the proximo-mesal margin and with a pale spot at the apex. Connexivum obscurely maculate segmentally.

Head with mesal spine half as long as first segment of antennæ, deep transverse dorsal constriction dividing head at posterior margin of eyes; rostrum with first and second segments subequal in length, each twice as long as third segment. Each half of anterior lobe of pronotum bearing one anterior and two posterior tubercles on the disc; short posterior lobe with four short conical spines in a transverse row; anterior femora incrassate, straight; anterior tibiæ curved; both femora and tibiæ armed below with a row of short rounded teeth; other legs slender, unarmed. Scutellum bearing a single long curved spine, over twice as long as head spine, somewhat larger than in *V. spicula*. Male with terminal dorsal segment armed with a mesal spine slightly shorter than the one on the head. Length, 6 mm.; breadth, 1.7 mm.

Holotype, male, from Teffe, Brazil.

Allotype, from the same locality.

SALYAVATINÆ.

Salyavata variegata Am. & S., from Yurimaguas, Peru. This species gives some trouble in using keys, from which it appears to belong to the Reduviinæ (Acanthaspidinæ Stal). The distinguishing character between the subfamilies is the presence of two-segmented anterior tarsi in the Salyavatinæ. The most conspicuous peculiarities of this species, the only representative of the subfamily in the western hemisphere, is the length of the antenniferous tubercles, which extend far beyond the short anteocular part of the head, and the long spines on each abdominal segment. The latter distinguish it from Veseris to which it seems to trace in Stal's synopses.

ECTRICHODIINÆ.

Mindarus sanguinosus Stal. One macropterous male from Teffe, Brazil, and a brachypterous female from Yurimaguas, Peru. A female nymph with an undivided, red-and-black-mottled pronotum may also belong here, although there are many structural differences.

Pothea ventralis St. F. and S. A specimen from Iquitos, Peru, lacks the black spot on the base of the head, and the connexival margins of the first five abdominal segments are black, the tip of the abdomen red as in the next species.

Zirta hirticornis Fabr., from Napo River, Peru.

Rhiginia amazona Stal, from Teffe, Brazil.

Ectrichodiella n. g. One specimen from the Sierra Maestra, Cuba, is a unique member of the family. At a glance it resembles a Trypetid fly or one of the Miridæ.

Generic Characters: Hemelytra slightly surpassing apex of abdomen, without a quadrangular or discordal areole, costal and anal areoles approximately equal in size, the anal extending farther proximad. Scutellum with the apex broad, bearing three long blunt points. Antennæ with first segment stout, slightly curved, nearly as long as head, second more slender, half longer than first, remainder of antennæ very slender, divided into five short sections making antennæ "7-segmented." Antennæ inserted close to eyes in a concavity protected laterally by a vertical expanded plate of the gena; antenniferous tubercles indistinct or wanting. Rostrum with the basal segment long, extending behind the eyes, subequal to second and third together, second somewhat swollen in the middle, longer than the third. Head broad, suddenly coarctate a little behind the small eyes; tylus compressed, elevated; ocelli large, well elevated, located distinctly behind caudal margin of eyes.

Pronotum unarmed, divided in front of the middle; prosternum short, with the usual median groove. Coxæ short, globose; anterior tibiæ expanded and excavated at tip but without a spongy fossa; legs entirely unarmed, except for very short spine at apex of femora on either side below; tarsi apparently two-segmented.

Abdomen broad, stout; abdominal spiracles minute, round; venter without a mesal carina except on the terminal ventral segment.

The insertion of the antennæ places this genus in a branch of the subfamily not heretofore reported from the western hemisphere, the nearest relatives being the Asiatic *Ectrychotes* Burm. (*Larymna* Stal) and *Labidocoris* Mayr, from both of which it differs in various characters of the legs and antennæ. The size is much smaller than other members of the sub-family, but the antennal, scutellar, wing and other characters seem to place it here without a doubt.

Ectrichodiella cubensis n. sp. Head, antennæ (except slender pale 5 apical segments) legs, and hemelytra nigro-fuscous. Thorax and abdomen flavescent, except first and last ventral segments and lateral margins, which are darker; dark border interrupted at each

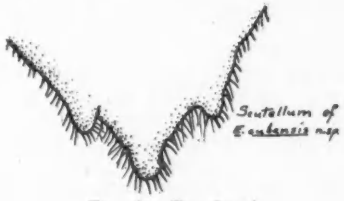


FIG. 1. *E. cubensis*

inter-segmental suture by a narrow pale line. Ocellar prominence elevated well above the level of eyes; ocelli white. Pronotum glabrous, shining, with both mesal and transverse grooves deep, neither interrupting the other; anterior lobe with a blunt elevation on the disk on each side and a small tubercle in front of the elevation; posterior lobe with a rounded swelling on the disk on each side and a smaller swelling at each lateral angle, posterior angles ampliate, extending caudad of the truncate posterior margin. Antennæ and tarsi pilose; head, legs, and body (except pronotum), sparsely clothed with fine pubescence; abdomen nearly glabrous, except at apex. Length, 5 mm.; breadth, 1.8 mm.

Holotype, female, taken on the summit of Palma Mocha Peak, Sierra Maestra, Cuba, altitude 5,540 feet, July 10–20, 1922, by C. H. Ballou and S. C. Bruner.

Two examples of this species in the Gundlach Museum are considerably smaller than the above. These are labeled "Ectrichodia minima Uhler," which is evidently a manuscript name as no description has been found.

STENOPODINÆ.

Pnirontis modesta Banks, described from Virginia and reported from Florida and Indiana, is now added to the Cuban fauna. The three specimens from Colon and Santiago de las Vegas, Cuba, answer Banks' description in detail except that the greenish cast, if present in life, has disappeared in the dried specimens, which are testaceous.

Pnirontis languida Stal, one specimen from Santiago de las Vegas, Cuba (J. Acuna).

Pnirontis infirma Stal, from Teffe, Brazil; Iquitos, Peru; and Santiago de las Vegas, Camaguey, and Jobabo, Cuba.

Pygolampis pectoralis Say, from Marianoa and Colon, Cuba. The length of the first antennal segment, which in this case equals that of the pronotum, is the most used diagnostic character in this genus.

Pnohirmus violentus Stal, from Iquitos, Peru.

Gnathobleda tumidula Stal, four specimens from Santiago de las Vegas, Cuba.

Stenopoda culiciformis Fabr., from Rodas, Colon, Santiago de las Vegas, Remedios, and Hoyo Colorado, Cuba, and from Hill Gardens, Jamaica.

Stenopoda cana Stal. Two males from Manaos, Brazil and Yurimaguas, Peru, and a female from Napo River, Peru, we take to be this species. The hemelytra have the anal margin distinctly sinuate next to the acute tip. The posterior and intermediate femora are not so distinctly infuscate near the apex as in *S. culiciformis* and the five yellowish bands of the venter are more definite but less conspicuously mottled with red. In the males the terminal dorsal segment is truncate instead of deeply bisinuate as in the northern species. *S. cana* is also much more strongly setose, especially on the femora, lateral margins of the pronotum, and basal segment of the antennæ.

Ctenotrachelus macilentus Stal, from Teffe and Manaos, Brazil.
Apronius rapax Stal, from Napo River, Peru, and Manaos, Brazil.
Narvesus carolinensis Stal, from Colon, Cuba.

APIOMERINÆ.

Heniartes flavicans Fabr., from Teffe, Brazil; and Iquitos, Peru. One of the specimens from Iquitos is without the typical white spots on the scutellum. Certain other variations occur, but as all four possess the two white lines between the eyes beneath and a second antennal segment much shorter than the third, and lack either a produced scutellum or a pair of dorsal tubercles on the disc of the anterior lobe of the pronotum, they are all referred to this species. The terminal ventral segment in the male is produced in the middle and armed with a pair of short stout divergent processes, contiguous at base.

Heniartes maestralis n. sp. An adult male and a nymph from the Sierra Maestra, Cuba. This is one of the handsomest of the Cuban Reduviids. It is not represented among the Gundlach specimens, which is rather surprising, as nymphs of the species were common in the higher Sierra Maestra mountains in July, 1922.

It differs from all species of Heniartes described heretofore in the black pronotum, bearing two bright red spots and the black band across the red corium.

Description. Brilliant black, red, and white coloration as follows: Head black with minute white spot between ocelli, one in front of each eye and two white lines between eyes beneath; rostrum black; antennæ black except base of third and fourth segments which are broadly flavescent; pronotum black with indistinct white mesal line and two large orange-red lateral maculæ on the posterior lobe extending forward to the transverse sulcus; scutellum black with the usual two white spots; corium bright red except broad transverse black band through the scutellum; membrane black; legs black except one broad flavescent or croceus annulus on each tibia; venter black except for segmental flavescent spots, and large bright red vitta on the disc and apex, anterior to the genital region, which is dark.

Body elongate. Head elongate, slender, equal to pronotum in length, decurved in front of the eyes, postocular part much longer than the ante-ocular; ocelli farther apart than the eyes; rostrum with second segment nearly as long as head, first and third segments extremely short; antennæ slender, first, third, and fourth segments subequal in length, second distinctly shorter.

Pronotum armed in front with prominent divergent tubercles at the anterior angles, with both transverse and median grooves deep, the latter not reaching the posterior margin; anterior lobe armed with a little tubercle on each dorsal convexity; angles and margins of posterior lobe unarmed. Scutellum triangular, acute at apex, apical half carinate. Legs long, slender, anterior tibiæ only slightly compressed, intermediate incurved at the apex; tarsal claws simple.

The terminal ventral segment in the male is broadly concave at apex and armed near each lateral angle of the concavity with a slender

process and a short tooth laterad of the process. Length, 14.5 mm.; breadth, 3.5 mm.

Holotype, male, collected on Palma Mocha Peak, Sierra Maestra, Cuba, altitude 3500–4200 feet, July 10–20, 1922, by C. H. Ballou and S. C. Bruner.

Apiomerus burmeisteri Guer., from Camaguey (J. Acuna), Los Palacios (P. Betancourt) and Nueva Gerona, Isle of Pines, Cuba. The Isle of Pines record is based on two specimens in the U. S. National Museum which have been identified as this species by Mr. H. G. Barber. These were erroneously recorded as *A. hirtipes* (Fabr.) in the Annals of the Carnegie Museum, Vol. XI, Nos. 3–4, 1917. The Cuban species is black, with the corium, line on propleura around insertion of coxæ, and spot on connexival segments deep red; unlike *A. hirtipes* the female is not provided with foliaceous genital appendages.

Apiomerus nigricollis Stal, from Teffe, Brazil. Eight specimens of the flavescent form, two of the black form.

Apiomerus pictipes Stal, a male and female from San Nicolas de Copan, Honduras.

Apiomerus elatus Stal, a male and female from San Nicolas de Copan, Honduras.

Apiomerus moestus Stal, from Melcher, Honduras.

Apiomerus nigrilobus Stal, from Teffe, Brazil.

Agriocoris flavipes Fabr., from Teffe, Brazil.

Calliclopius nigripes Linn. Two specimens of Stal's variety *albipennis* from Iquitos, Peru.

ZELINAE

Cosmoclopius nigroannulatus Stal, from Teffe, Brazil, is very similar to our North American species of *Pselliopus* (*Milyas*) in appearance, differing in the unarmed lateral angles of the pronotum, and the acute posterior angle of the scutellum.

Pselliopus nigropictus Champ., from San Pedro Sula, Honduras. The single specimen agrees with Fowler's figure and description except that the lateral angles of the pronotum are somewhat shorter.

Zelus rubidus St. F., from Santiago de las Vegas, Taco Taco, Vinales, Perico, Soledad, Cienega de Zapata, Ceballos, and the Isle of Pines, Cuba. This conspicuous species is the commonest member of the family occurring in Cuba. We also have a specimen from Unity, Jamaica, collected by A. C. Gowdey.

Zelus mactans Stal, from Manzanillo, Camaguey, and Santiago de las Vegas, Cuba.

Zelus subimpressus Stal, from Taco Taco, Vinales, Hoyo Colorado, and Santiago de las Vegas, Cuba.

Zelus annulosus Stal, from Teffe, Brazil.

Zelus janus Stal. Two specimens from San Jose, Honduras, and Yurimaguas, Peru, are somewhat doubtfully referred to this species. The general color of the first is testaceous, the legs being entirely immaculate; the anterior lobe of the pronotum is marbled with black and the

membrane lightly infuscated. The specimen from Peru has the legs black, with the apex of the femora and base of the tibia bright rufous; the disc of the anterior lobe of the pronotum is black and the posterior lobe as a large black transverse macula; the membrane is black. The first of these is somewhat more pubescent, especially on the pronotum, but structurally the two are very similar, although a larger series may show them to be distinct.

Zelus nugax Stal, from el Cerron, Honduras.

Notocyrtus dorsalis Gray, from Agua Blanca, Honduras; Teffe, Brazil; and Iquitos, Peru, also including a specimen of the variety *flavolineatus* Stal from the latter locality.

Acanthiscium maculatum Am. et S., variety *plagiatum* Stal, from Iquitos, Peru.

Myocoris nugax Stal, from Teffe, Brazil, and Iquitos, Peru.

Graptocleptes fasciatus Fabr, from Teffe, Brazil.

Castolus plagiaticollis Stal, from Melcher, Honduras.

Castolus multicinctus Stal, variety *nigrocoris* n. var. A female specimen with a black corium from Santiago de las Vegas, Cuba, appears to be a dark form of this species. The related *C. plagiaticollis* from Mexico and Central America is known to occur in two forms, one with a pale corium, the other with the corium and the head above black or nearly so. In the specimen at hand the tubercle behind the antenna is more distinct than Stal's description indicates, but otherwise the differences are insignificant. The new variety may be separated from other species of the genus by the color and from the dark variety of *plagiaticollis* by the short tubercle mentioned. It is possible that comparison with specimens of *multicinctus* will show that the Cuban insect is worthy of specific rank. An example of the latter is preserved in the Gundlach Museum, bearing the number 167.

Repipta taurus Fabr. Three specimens from Panama collected by C. M. Ballou, November 9, 1923. Three specimens also from Tela, Melcher, and San Pedro Sula, Honduras, seem referable to this species, although somewhat distinct in coloration. Each has the corium infuscated, the head immaculate, and one has dusky lateral vittæ on the pronotum, this being immaculate in the others. The legs of one are black with the femora reddish at the base, another has light red legs, while in the third these are yellow. The latter specimen agrees perfectly with Champion's figure of *R. flavicans*, but appears to be only a color phase of *taurus*.

Repipta flavicans Am. et. S., from Teffe, Brazil. The specimens at hand are testaceous in color with indistinct dusky lateral vittæ on the pronotum; all are smaller and appear somewhat more slender than *R. taurus* from Honduras.

Repipta fuscipes Stal. A male from San Pedro Sula, Honduras, has the posterior lobe of the pronotum entirely bright red except for the anterior margin and spines, which are black, and two barely perceptible dusky vittæ on the disc.

Lindus ericius Champion, from Iquitos, Peru—a new locality record.

Rocconota hystricula Champion, from Teffe, Brazil—a new locality.
Atrachelus crassicornis Fabr., from Teffe, Brazil, and Iquitos, Peru.
Atrachelus cinereus Fabr., from Santiago de las Vegas, Cuba.
Ricolla quadrispinosa Linn., from Napo River and Iquitos, Peru, and from Teffe, Brazil.
Ricolla nigripes Stal, from Teffe, Brazil, and Iquitos, Peru.
Rivolla pallidinervis Stal, from Venturia, and Rio Pescado, Ecuador.
Ricolla simillima Stal, from Lake Yojoa, San Nicolas de Copan, and Tela, Honduras.

Hygromystes, Subgenus **Ceballum** n. subg. A specimen of *Hygromystes* from Ceballos, Cuba, represents a new subgenus and new species.

Subgeneric Characters: Head elongate, as seen from the side with the dorsal and ventral surfaces parallel, suddenly coarctate at base, not convergent except as seen from above; ocelli not elevated; rostrum with the first segment longest, extending to caudal margin of eyes, second nearly as long, third very short. Body very elongate, slender, sides parallel. Pronotum longer than head, bearing a short spine at each lateral angle, unarmed on the disc; femora bispinous at the apex; anterior shorter than the posterior; scutellum longer than wide, postscutellum inconspicuous, not produced; sides of mesosternum without a tubercle or fold in front. Abdomen with the first two segments armed at the lateral apical angles with a spine, the third with a minute tooth.

Members of the genus *Hygromystes* are separated from most Zelinæ by the bispinous knees, from *Ricolla* by the suddenly coarctate base of the head and the absence of lateral spines from the fourth and fifth abdominal segments (except in *H. bicarinatus* Stal), and from Asiatic forms with bispinous knees by the unarmed (except at the apex) anterior femora.

Within the genus, the species possessing four spines on the pronotum are placed in the subgenus *Doldina* Stal, those with two spines in the new subgenus *Ceballum*, and those with the pronotum unarmed in the subgenus *Hygromystes* Stal.

Hygromystes (**Ceballum**) **armatus** n. sp. Flavescent throughout, the head and the sides of the meso- and metathorax somewhat darker. Body, legs, and base of antennæ covered with fine white pubescence. Pronotum with the median impression linear, shallow, indistinctly surpassing transverse groove to posterior lobe; pronotal carinæ obscure. Spines of head at base of antennæ small; pronotal spines slender, somewhat longer than the tarsal claws. Eyes rather small, round, black; ocelli yellow. Antennæ much longer than body, first segment distinctly longer than head, pronotum and scutellum together. Anterior tibiæ with well developed compressed tooth in front near apex; tarsi with first joint very short; second and third long, slender, subequal in length. Hemelytra not reaching apex of abdomen. Apex of terminal abdominal segment of male produced into a short curved vertical spine. Length, 17.5 mm.; breadth, 2 mm.

Holotype, male, from Ceballos, Camaguey Province, Cuba, collected by Patricio Cardin.

There is a specimen of this insect with the Number 422 in the Gundlach Museum.

This seems to be the first member of the genus found north of Brazil. It is one of the most elongate and slender of the Reduviidæ and somewhat resembles the Coreid *Protenor belfragei* in appearance.

Sthienera (Erbessus) grossus Stal, from Iquitos, Peru.

Ploeogaster lividus Stal, from Yurimaguas, Peru.

Montina distincta Stal, from Teffe, Brazil.

Montina confusa Stal, from Yurimaguas and Iquitos, Peru.

Montina fumosa Stal, from Iquitos, Peru. Whether these three forms of *Montina* represent distinct species is somewhat questionable.

Arilus carinatus Forst. A single male from Napo River, Peru, is intermediate between the described species of this genus. The crest bears eleven tubercles and the sides of the pronotum are about as dilated as in *A. gallus* Stal, but the margins of the abdomen are distinctly and deeply sinuate. The tibiæ and tarsi are all ferruginous, as well as the anterior coxæ and the base and apex of the anterior femora.

Heza acantharis Linn., from Santiago de las Vegas (B. Barreto) and Camaguey (J. Acuna), Cuba.

Heza clavata Guerin, from Taco Taco, Los Palacios, Santiago de las Vegas, Bainoa, and Bahia de Cochinos, Cuba.

Sinea caudata Champ., from San Pedro Sula, Honduras.

Sindala acuminata n. sp. (Uhler MS.)

Although mentioned in literature, this species has apparently never been described. A male from eastern Cuba agrees with specimens bearing this name in the Gundlach Museum, which were probably determined by Uhler. The species may be recognized by the shape of the abdomen, the posterior margins of which are strongly dilated to form an acute angle on each side anterior to the apex. The width of the abdomen is greater than that of the pronotum in both sexes.

Description. Dark brown; corium, anterior connexival segments, indistinct area between the lateral angles and apex of abdomen, and legs paler; apex of tibiæ and of intermediate and posterior femora darker; tarsi brown; long second joint of the antennæ rusty brown with indeterminate lighter band beyond center, other segments fuscous; below somewhat paler, venter testaceous, genital region infuscated.

Body moderately elongate, spinose tuberculate, sparsely clothed with very minute, short prostrate pale hairs, except membrane and more elevated parts; anterior femora with long slender erect white hairs, a few similar but shorter hairs on intermediate and posterior femora, and on tibiæ, with short rigid setose hairs on lower surfaces of these and of coxæ, more abundant on apex of tibiæ.

Head moderately narrow, more than twice as long as broad, subequal in length to pronotum, armed with two very large vertical spines

placed close together above eyes, marked with scattered tubercles, and as long as depth of head; anterior to these are two shorter spines on either side in line with the attachment of antennæ, less than one-half the length of the former, slightly divergent and inclined forward; between the anterior pair of these spines in line transversely are two minute rounded tubercles and just behind a small median spine; ocelligerous part of head elevated, two short stout spines on each side above ocelli, the second of these larger and inclined slightly to the rear; rest of head and neck with conspicuous scattered conical tubercles; eyes rather small, black, shining; rostrum with basal segment extending slightly behind eyes, subequal in length to second, apical segment one-half the length of preceding. Antennæ filiform, composed of the usual four long segments but with a small inconspicuous secondary segment at the base of the first, second, and third, respectively. Of the longer segments, the first is smooth, almost bare, equal in length to the head; second and third together about equal to first; fourth shorter than third; second, third and fourth pubescent.

Pronotum broader than long, the two lobes of equal length; anterior lobe less than one-half the width of posterior lobe, covered with numerous shining rounded subconical tubercles of irregular size, armed on convex disc with two stout tuberculate spines, followed by two similar but smaller spines; posterior lobe provided above with two prominent, somewhat compressed, tubercular processes, equidistant from each other and lateral angles, whole surface closely and coarsely pitted; lateral angles produced into an acute spine directed slightly upward and to the rear, posterior margin of these set with row of small teeth. Scutellum unarmed, sculptured, apex rounded. Membrane not reaching apex of abdomen, veins well marked, black, slightly raised. Anterior femora incrassate with contoured surface, closely covered with small rounded tubercles and scattered growth of long thin white hairs, armed above near apex with smooth sharp spine, this dark with yellowish apex, directed forward, as long as greatest diameter of femur; below with a double row of similar but shorter spines, three on outside and two inside, the first of latter very small, between these numerous minute conical spines. Intermediate and posterior femora unarmed, slightly incrassate, especially near apex, surface contoured, with an occasional small rounded tubercle. Tibiæ unarmed, anterior pair with inner margin of apex produced into short tooth.

Abdomen concave, sides strongly dilated near apex to form an acute angle, breadth greater than that of pronotum. Length, 10 mm.; breadth, pronotum, 3 mm.

Holotype, male, collected at Jobabo, Oriente Province, Cuba, on September 14, 1922, by B. T. Barreto.

A female of this species in the Gundlach Museum has the abdomen much more greatly dilated than the male, this being one and one-half times the width of the pronotum, and the hemelytra reach the apex of the abdomen.

NOTES ON CENCHREA WESTWOOD AND CEDUSA FOWLER IN AMERICA (HOMOPTERA: FULGOROIDEA).

By W. L. McAtee.

While the genera *Cenchrea* and *Cedusa* (*Lamenia* of authors, not of Stal) have been more or less confused, they are not very closely related. The antennal trough, that reflector-like structure which forms a guard for the highly sensorial antennæ and which appears to be an organ of importance, is an appendage of the pronotum in *Cenchrea* and of the head in *Cedusa*. Such a structural difference must be given considerable weight in classification and when the Fulgoroidea are revised throughout on the basis of structure, these two genera will not stand together as the catalogs now have them. However, they agree in having no prominent, longitudinal carina on the frons, and in possessing a low, rounded one on clypeus, which with the slightly prominent sides gives that member a moderately tricarinate appearance.

The bulk of the material upon which this paper is based was collected by the writer, but the National Museum collection, of which he is Acting Custodian, also has been used. Dr. E. D. Ball very generously loaned his material, including the types of species described by him, and Mr. J. R. Malloch has kindly collected and contributed numerous specimens. Dr. Ball also furnished notes on the genital characters of Fitch's species, *vulgaris*. Mr. F. Muir has written me about important characters of these and other genera of the Derbidæ, submitted to me before publication a manuscript on this subject, and sent me a specimen of *caliginea*, the genotype of *Lamenia*, all of which aid has been greatly appreciated. Dr. Z. P. Metcalf kindly forwarded for examination males of his species, *Herpis australis* and *H. incisa*.

Genus **Cenchrea** Westwood.

Cenchrea Westwood, J. O., Observations on the genus Derbe of Fabricius. Trans. Linn. Soc. Lond. 19, 1845, p. 15, Pl. 2, Fig. 8. [Monobasic, *C. dorsalis* n. sp. genotype, St. Vincent Id.]

Herpis Stal, C., Bidrag till Rio Janeiro-Traktens Hemipter-Fauna, K. Vet.-Akad. Handl. 3, No. 6, 1861, p. 8. [Five species included; type by subsequent designation, *H. fuscovittata* Stal, Brazil.]

Syntames Fowler, Canon., Biologia Centrali-Americana, Rhynchota, Homoptera, 1, pp. 138-139, Pl. 13, Fig. 21, March, 1905. (Monobasic, *S. delicatus* n. sp. genotype. Guatemala, Panama.]

Neocenchrea Metcalf, Z. P., A key to the Fulgoridæ of Eastern North America with descriptions of new species. Journ. Elisha Mitchell Sci. Soc., 38, May, 1923, pp. 193-194. [*Cenchrea heidemanni* Ball, named as type.]

Ranged above are the names of all the proposed American genera known to the writer, that have the pronotum foveate (Stal), with an auriculate cavity (Van Duzee), that possess well-developed shoulder keels (Muir), or that have what the present writer calls the antennal trough as an appendage of the pronotum. All of these expressions are intended to describe the same thing, and it is an important character of a group* which may be called a genus, tribe, or subfamily according to taste. The writer prefers to treat the assemblage as one genus and although there are venational distinctions upon which subgenera can well be founded, these characters are not well enough known for all of the groups above listed to enable the names to be applied with precision. For the same reason, the proposal of new names is inadvisable; there may be a name available for each subgenus when their proper application is understood.

Apparently distinctive characters of the genus Cenchrea drawn from the six (a seventh damaged) species seen are: Lower margin of pronotum with an upcurved lamina forming lower border of antennal trough, genal ridge prominent but not produced; margins of vertex and frons elevated and granulate; face distinctly inwardly angulate at junction of frons and clypeus; pronotum angulate-emarginate posteriorly; veins of tegmen tending to be granulate, the subcostal vein usually and the claval veins always distinctly so; claval veins uniting at or behind middle of commissure; margin of tegmen serrulate apically. Venation has been figured by Westwood, Kirkaldy, and Metcalf in papers cited in generic synonymy. All of the species have the carinæ of head more or less fuscous-edged.

The genotype, *C. dorsalis* is a species quite closely related to *C. uhleri*, from which it would appear to differ in color in having two dark spots instead of one, and in lacking red veins, in apex of fore-wing.

* At least five other described cenchreine genera from other parts of the world have the same character.

KEY TO THE SPECIES.

1. Subcosta, medius, and cubitus of forewing each with a long fork and with but few interconnecting veins before extreme apex of tegmen; no distinct series of anteapical cells; tegmina whitish.....2
   Subcosta, medius, and cubitus of forewing with shorter forks, more freely connected by cross-veins and anastomosing so that there is a distinct series of anteapical cells; tegmina not whitish.....4
2. Vertex less than twice as wide behind as in front, angularly emarginate posteriorly, eyes only slightly overlapping pronotum, the latter angulate anteriorly, corresponding to the emargination of head; juncture of vertex and frons distinctly angulate as seen from side; eye less emarginate than in alternative group; tegmen lacking dark spots in apical cells.....3
   Vertex more than twice as wide behind as in front, broadly emarginate posteriorly, eyes overlapping pronotum for nearly half their length, the latter squarishly produced anteriorly corresponding to emargination of head; juncture of vertex and frons barely angulate as seen from side; emargination of eye including geometrical center of that organ; tegmen with dark spots in apical cells.....*bakeri*, new species
3. Superior border of antennal trough merely a ridge, scarcely laminate-elevated.....*heidemanni* Ball
   Superior border of antennal trough distinctly laminate-elevated, *lineata* Fabricius
4. Subcostal vein forking before middle of tegmen; cells immediately behind juncture of medius and cubitus with nearly straight sides.....5
   Subcostal vein forking behind middle of tegmen; cells immediately behind juncture of medius and cubitus with distinctly curved sides; tegmen with three conspicuous black spots along claval suture....*exquisita* Uhler
5. Mesonotum and tegmina uniform fuscous.....*brunnea* new species
   Mesonotum fulvous; tegmina testaceous with more or less dark markings along costa, and spots and veins at apex red.....*uhleri* Ball

DESCRIPTIONS OF THE SPECIES.

C. bakeri new species. General color pale testaceous, the wings with more or less snowy pruinosity, and the membrane whitish, a few dusky dots in apical cells; fuscous margining of carina of head more prominent, especially above eyes, than in the other species; mesothorax in one specimen (probably a male) castaneous except on disk; lateral carinæ of vertex and frons high, the transverse carina inconspicuous, frons long and narrow widening slightly from base; serrulation of tegmen extending from point on costa about two-thirds from base nearly to inner apical angle. Length about 6–7 mm. Holotype ♀ and another specimen (sex uncertain), Mexico, C. F. Baker (No. 2154). (U. S. N. M.)

C. heidemanni Ball, E. D. Can. Ent. 34, No. 10, Oct., 1902, p. 261 [Kans., D. C.]. Head and thorax pale orange-yellow, remainder whitish with more or less snowy pruinescence. Vertex and frons with high lateral carinæ, frons parallel-sided on upper two-thirds then abruptly flaring. Tegmen serrulate from middle of costal margin nearly to inner apical angle. Outer claspers of male slightly separated at base, the inner margins then approaching each other, and together enclosing a distinctly square opening, a diagonal of which is the median line of the genitalia. Length 6.5–8 mm. Localities: Plummers Id., Md., July 26, Aug. 2, 16, 1914, Dalecarlia Reservoir, D. C., Aug. 22, 1915, W. L.

McAtee; Glen Echo, Md., Aug. 21, 1921, Aug. 22, 1922, Chain Bridge, Va., Aug. 20, Sept. 17, 1922; Chesapeake Beach, Md., Aug. 16, 1923, J. R. Malloch.

C. lineata Fabricius. **Cicada lineata** Fabricius, J. C. Syst. Rhyng., 1803, p. 66 [Middle America].

In general appearance almost a duplicate of *C. heidemanni*, the most important character separating them (on the basis of specimens examined which include no males of this species) being the difference in antennal trough mentioned in key. The vertex and frons have high lateral carinæ, and the frons widens gradually almost from the upper end. Serrulation of tegmen about as in *C. heidemanni*. Length 7 mm. Locality: St. Vincent Id., W. I., H. H. Smith. (U. S. N. M.)

C. exquisita Uhler, P. R. Proc. Zool. Soc. Lond., 1895, pp. 69–70 [St. Vincent]. Head and body pale testaceous, cheeks each with a dusky streak, and clypeus with 3 triangular dark spots; tegmen whitish hyaline with snowy pruinosity along costa and on corium near clavus; a reddish-orange patch in base of clavus and another on inner apical angle of wing extending to juncture of medius and cubitus; narrow dusky markings as follows; a dash on medius before fork, a dot in costal cell, an oblique band from costa beginning just anterior to the notch, one band across apical and one across ante-apical cells, and a series of 3 bold rounded black spots on corium next to clavus, adjacent to the basal one of which; is a trapezoidal black spot on middle of clavus. Lateral carinæ of vertex and frons rather high, transverse carina prominent, vertex about as wide behind as long, frons broad, almost parallel-sided. Tegmen serrulate around entire apical margin. Outer claspers of male much narrowed near base resulting in their enclosing a considerable elliptical space into which projects a blunt tooth from either clasper, the apices of claspers a little curved inward and bluntly pointed. Length 4 mm. Locality St. Vincent Id., H. H. Smith (U. S. N. M.)

C. brunnea new species. General color fuscous, pronotum, most of head, and legs stramineous. Vertex about as in *C. uhleri*, frons narrower but widening gradually from upper end. Tegmen serrulate between inner and outer apical angles the extreme apex narrowly red. Claspers of male similar to those of *C. uhleri* (Fig. 1), but straighter on inner side more widely separated, and apical hook smaller. Length 3.5–4 mm. Localities: Chagres River, Canal Zone, Oct. 9, 1917, H. Morrison (holotype, ♂); Cayuga, Guatemala, October, 1915, Wm. Schaus; Mexico, C. F. Baker (Nos. 1785, 2154). (U. S. N. M.)

C. uhleri Ball, E. D. Can. Ent. 34, No. 10, Oct. 1902, p. 261 [D. C., Md., Kans.]

Head and thorax testaceous, tegmen stramineous, usually with the following dark markings: dusky on apical third, the clavus with a narrow and the costa with a broader, dusky to black marginal streak, outer apical angle with a dense black spot, apical margin and more or less of the veins near it red. Vertex about as long as wide at base, lateral carinæ moderate, transverse carina distinct, frons board, widening gradually from upper end. Tegmen serrulate between inner and

outer apical angles. Clasper of male as in Fig. 1. Length 4.–5.5 mm. Localities: Various localities in Maryland and Virginia near the District of Columbia where it is a common insect; Bluemont, Va.; Raleigh, N. C. Recorded also from New Jersey.

DESCRIBED NORTH AMERICAN SPECIES NOT SEEN.

C. dorsalis Westwood. Genotype. Bibliographic reference same as for the genus.

C. delicatus Fowler. See synonymy of genus.

C. fulva Van Duzee, E. P. Bull. Buffalo Soc. Nat. Sci. 9, No. 2, 1909, p. 195 [Florida.]

Genus **Cedusa** Fowler.

Cedusa Fowler, Canon. Biologia Centrali Americana, Homoptera 1, p. 112, Nov. 1904. [With two included species, *C. funesta* and *C. venosa*, of which the former has been selected as the genotype. Mexico.]

Characters of value in distinguishing this genus (and especially in contrasting it with *Cenchrea*) are: Lower margin of pronotum without up-curved lamina, the lower part of antennal trough being formed by a more or less scoop-shaped process of the genal ridge; margins of vertex and frons but slightly elevated and lacking granulations; face merely depressed, not distinctly inwardly angulate at junction of front and clypeus; pronotum rounded, scarcely angulate-emarginate posteriorly; veins of tegmen lacking granulations, all veins of corium running together at base of wings, forking posteriorly and connected by cross-veins so that there is a distinct series of ante apical cells; about 3 of the apical cells are formed by secondary forking of the longitudinal veins; claval veins joining at about middle of clavus, tegmen not serrulate apically. Venation has been figured by Metcalf (Ann. Ent. Soc. Amer. 6, 1913, Pl. 35, Fig. 41.)

In color most of the species are fumose to black, more or less covered with bluish-gray pruinosity; all of the species agree in having the transverse veinlets cutting off apical cells more or less whitish; in the dark species the lower surface, especially the venter is often marked with red. The only reliable characters found for separation of the species are the details of the male genitalia. Besides the characters illustrated it may be mentioned that the apical sternite is rounded-angulate in *C. flavida*, *C. inflata*, and *C. bedusa* (Figs. 4, 8, 12) and straight or slightly convex in the other species. Without reference to internal genital characters which were not studied, it must be said that the genitalia of the females are very uniform in structure. *C. maculata* is distinguished by the broad, terminal process of the apical sternite (See Fig. 3), but in the other species this sternite varies only in being a little more, or a little less angulate, differences in appearance as illustrated in Figs. 7 and 14a, being due merely to varying positions of the sclerites concerned. The shape of the frons is described for most of the species but it must be noted that variations occur due to the degree of maturity of the specimens at time of death.

Assignment of *Pæciloptera* (?) *vulgaris* Fitch and related species to *Lamenia* Stal dates from Uhler, 1889 (Standard Natural History, II, p. 233) and confusion as to the application of a number of generic names for the atypical Derbidæ has been great. These matters are discussed in a recent paper by F. Muir, Notes on some genera of Derbidæ (Proc. Ent. Soc. Wash.*) and the writer notes here only a few characters not mentioned in Mr. Muir's article. The lateral carinæ of vertex and frons are thicker and more elevated in *Lamenia* than in *Cedusa* and together with the costa, and claval veins, are conspicuously granulate. In *Lamenia* the pronotum is angulate-emarginate behind and has a distinct elevated median carina, characters not possessed by *Cedusa*. The venation of the former genus, details of which are described by Mr. Muir, is much simpler than that of the latter.

KEY TO THE SPECIES.

1. Genal ridge forming a high carina between antennal trough and lateral carina of frons joining latter on its own level; transverse carina between vertex and frons nearly obsolete 2
   Genal ridge low, distinctly depressed between antennal trough and lateral carina of frons; transverse carina between vertex and frons evident, usually distinct 3
2. General color stramineous with numerous fuscous spots and stripes; last sternite of male nearly transverse (Fig. 2), of female, produced as a broad process which is slightly emarginate medianly, (Fig. 3); length, 4.5–5.5 mm ..... *maculata* Van Duzee
   General color pale yellowish, mesonotum pale orange, lacking fuscous spots and stripes; last sternite of male slightly rounded-angulate medianly, (Fig. 4); length, 4 mm ..... *flavida* Van Duzee
3. Mesonotum and parts anterior chiefly fulvous, tegmina more or less dusky apically, fulvous basally; low longitudinal carina of frons fairly distinct; outer clasper of male as in Fig. 5 ..... *edentula* Van Duzee
   Mesonotum (in mature specimens) always, and parts anterior usually, dusky to black; tegmina dusky 4
4. Low, broadly rounded longitudinal carina on frons fairly distinct;† head always, and pronotum usually with more pale coloration than in the contrasted group. See figures of genitalia and descriptive notes to identify the species.

   californica Van Duzee, Fig. 14a.
   praecox Van Duzee, Fig. 10.
   bedusa new species, Fig. 12.
   cedusa new species, Fig. 23.

   Frontal carina indistinct or lacking; pronotum never pale and head with no more than the raised margins of frons, the antennæ, and antennal troughs, pale. See figures of genitalia and descriptive notes to identify the species.

   incisa Metcalf, Fig. 17.
   funesta Fowler, Fig. 21.
   obscura Ball, Fig. 11.
   inflata Ball, Fig. 8.
   vulgaris Fitch, Fig. 13.
   fedusa new species, Fig. 6.
   gedusa new species, Fig. 18.
   hedusa new species, Fig. 9.
   kedusa new species, Fig. 24.
   ledusa new species, Fig. 15.
   mallochi new species, Fig. 22.
   nedusa new species, Fig. 20.
   pedusa new species, Fig. 19.
   redusa new species, Figs. 13, 23, (See text).
   redusa new species, Fig. 14.
   vedusa new species, Fig. 16.

---

* 26 No. 1, Jan. 1924, pp. 15-19.

† This is more a matter of appearance due to color than to structural difference, and the other color characters noted are cited in the key more for a certain degree of convenience they may afford rather than on account of definite value in separating species. The only safe critera to species are the genital characters.

C. maculata Van Duzee, **Lamenia maculata** Van Duzee, E. P. Bul. Buffalo Soc. Nat. Sci. 10, 1912, pp. 503-504. [Ontario]. Our largest and only spotted species, agreeing with *C. flavida* in having the transition from vertex to front more rounded than in most of the other species and in having similarly shaped male claspers (Fig. 2). Female genital segment as in Fig. 3. Lower third of front abruptly expanded. Length, 4.5–5.5 mm. Common in the vicinity of Washington, D. C., from August to October. Recorded also from Ontario and North Carolina.

C. flavida, Van Duzee, **Lamenia flavida,** Van Duzee, E. P. Bull. Buffalo Soc. Nat. Sci. 8, 1907, p. 36. [Jamaica]. The most uniformly yellowish species seen, agreeing with *C. maculata* in several important characters as noted in key and description of that species. The tegmen is extensively clouded with dusky apically. The front expands gradually from vertex to juncture with genal ridges. Outer clasper of male, ventral view as in Fig. 4, lateral view much as in Fig. 10. Male paratype, Mandeville, Jamaica, April, 1906, E. P. Van Duzee (U. S. N. M.)

C. edentula, Van Duzee, **Lamenia edentula,** Van Duzee, E. P. Bul. Buffalo Soc. Nat. Sci., 10, 1912, p. 503. [Georgia]. A strongly fulvous species easily separable from the others. Front gradually widened almost to apex. Ventral view of male clasper as in Fig. 5; lateral lobe as seen from side much as in *C. incisa* (Fig. 17); apical hook nearly obsolete. Length, 3.75–4.5 mm. Common about Washington, D. C., in July and August. Recorded also from New Jersey and North Carolina.

C. californica, Van Duzee, **Lamenia californica,** Van Duzee, E. P. Can. Ent., 23, No. 8, August, 1891, p. 169. [California]. Tegulæ, pronotum and head distinctly yellow in strong contrast to the blackish mesonotum and tegmina. Frons widest just below the middle, more gradually narrowed below than above that point. Ventral view of outer clasper of male as in Fig. 14a; lateral lobe as seen from side somewhat as in *C. obscura* (Fig. 11) but more rounded. Last sternite of female as in Fig. 14a. Length, 4–5 mm. Localities: Los Angeles, Calif., D. W. Coquillett; Arizona, C. F. Baker, and Cornell University Expedition; Colorado, C. F. Baker. (U. S. N. M.); Phoenix, Ariz., May, 1897, Ft. Collins, Colo., July 2, 7, 1898, Palisade, Colo., July 8, 1901, E. D. Ball (Ball.)

C. praecox, Van Duzee, **Lamenia praecox,** Van Duzee, E. P. Bul. Buffalo Soc. Nat. Sci. 10, 1912, pp. 502–3, [Huachuca Mts., Ariz.]; *Herpis australis* Metcalf, Z. P., Journ. Elisha Mitchell Sci. Soc., 38, 196–197, May, 1923 [Texas.] Coloration as in *C. californica* the paler areas, especially the pronotum, showing a greater tendency to be obscured by dusky. Frons widest at a point about three-fourths its length from vertex, the sides somewhat incurved above, and slightly outcurved below. Ventral and lateral views of outer clasper of male as in Fig. 10, apical hook may be curved either upward or downward. Length, 4–4.5 mm. Localities: Las Vegas, Hot Springs, N. Mex.; Aug. 2, H. S. Barber; Brownsville, Tex., George Dorner, [type material

of *H. incisa* Metcalf]; Devil's River, Tex., F. C. Bishopp and F. C. Pratt (U. S. N. M.); Bransom, Mo., Aug. 18, 1916, on red cedar, E. H. Gibson (Gibson).

C. bedusa new species. While this species and the next have the pronotum somewhat paler than it usually is in the dark species of the genus, only rarely is it clear yellow as in *C. californica;* the head, however, has much more pale markings than normally occur in the other group. Frons widest at a point about two-thirds its length from vertex, the sides a little concave above that point, straight and gradually convergent below. Ventral view of outer clasper of male as in Fig. 12; lateral lobe as seen from side, much the shape of that of *C. incisa* (Fig. 17) but not quite so broad; apical hook nearly obsolete. Length, 4.75 mm. Holotype, ♂, Glencarlyn to mouth of Four-mile Run, Va., June 17, 1914, W. L. McAtee.

C. cedusa new species. Remarks on color under preceding species apply here. Frons also as in *C. bedusa*, but widest at three-fourths its length from vertex. Ventral view of outer clasper of male as in Fig. 23; lateral lobe as seen from side somewhat as in Fig. 13, but higher and more broadly rounded; apical hook broad as viewed from below, abruptly pointed and upcurved as seen from behind, (Fig. 23). Length, 4.25–5 mm. Holotype and paratypes, ♂'s, Plummers Island, Md., August 25, 1904, R. P. Currie; paratype ♂'s, Uhler Collection (U. S. N. M.), and Dunn Loring, Va., August 30, 1916, W. L. McAtee; Glen Echo, Md., July 19 (Ball).

C. incisa Metcalf. **Herpis incisa** Metcalf, Z. P. Journ. Elisha Mitchell Sci. Soc., 38, pp. 195-196, May, 1923, [Conn.]. Frons broadest about two-thirds its length from vertex, the sides above that point a little incurved, below it more strongly outcurved. Ventral and lateral views of outer clasper of male as in Fig. 17, apical hook rather prominent, upcurved. Length, 3.75–4.5 mm. Localities: New Haven, Conn., July 2, 1920, B. H. Walden, type material (Z. P. Metcalf); New York, 5272, Fitch; New York, 2334, C. F. Baker; Princeton, Uhler Collection; Agr. College, Mich., 243, C. F. Baker, (U. S. N. M.); Delaware Water Gap, N. J., July 12; Ames, Iowa, July, August (Ball).

C. funesta Fowler. **Cedusa funesta** Fowler, Canon. Biol. Centr. Amer. Homop. 1, p. 112, Nov. 1904, [Mexico, Guatemala]. Frons broadest about two-thirds of its length from vertex, only slightly narrower above and below that point, the sides a little incurved. Ventral view of outer clasper of male as in Fig. 21, lateral view somewhat as Fig. 14, the lobe narrower apically, apical hook small. Length, 4–4.5 mm. Locality: Teapa, Tabasco, Mexico, H. H. Smith. A male and a female paratype, (U. S. N. M.).

C. obscura Ball, **Lamenia obscura** Ball, E. D. Can. Ent. 34, No. 10, Oct., 1902, p. 262. [Colorado, Florida]. Frons widest about three-fourths of its length from vertex, the sides notably incurved above, especially between eyes, slightly convex and but little convergent below widest point. Ventral view of outer clasper of male as in Fig. 11, lateral lobe much as in Fig. 14, but more rounded, apical hook of moderate

size, thin, pointed, varying somewhat in width, (Fig. 11). Length, 3–4 mm. Localities: Greeley, Colo., August 5, 1901, E. D. Ball (Ball), the type material; Colorado, 1918, C. F. Baker, (U. S. N. M.). Van Duzee's reference (Bul. Buffalo Soc. Nat. Sci. 10, No. 2, 1912, p. 502) to this species, evidently is confused, as two types of male genitalia are attributed to it. Since most of the localities given are eastern it is possible this author did not have *L. obscura* at all at the time. *C. bedusa* with similar genitalia (Fig. 12) to those of *C. obscura* and some other form may have been represented.

C. inflata Ball, **Lamenia inflata** Ball, E. D. Can. Ent. 34, No. 10, Oct., 1902, pp. 262–3, [Haiti]. Frons broadest about three-fourths of its length from vertex, the sides above nearly straight and only slightly converging, rather strongly out-curved below. Ventral view of outer clasper of male as in Fig. 8, lateral lobe somewhat as in Fig. 14, but more pointed, apical hook broad basally, directed straight inward, attenuate and very finely pointed apically. Length, 3.5–4 mm. Localities: Port au Prince, Haiti, December, January, February, R. J. Crew (Ball), the type material; Romana, Dominica, April 9, 1913, W. V. Tower, (U. S. N. M.).

C. vulgaris Fitch. **P[oeciloptera]** (?) **vulgaris** Fitch, Asa. Ins. State Cabinet Nat. Hist., Fourth Ann. Rep. Regents Univ., N. Y., 1851, p. 47. Frons widest about four-fifths of its length from vertex, the sides above slightly incurved and gradually convergent, straight and convergent below. Ventral and lateral views of male clasper as in Fig. 13, apical hook rather long, slender and moderately curved anteriorly. Length, 3.5–4.5 mm. Localities: Forest Glen, Md., June 13, 1915; Plummers Island, Md., June 17, 1906, June 8, 1913, W. L. McAtee; Glen Echo, Md., June 10, 17, 1923, J. R. Malloch; Mt. Vernon, Va., June 6, 1915, W. L. McAtee. Recorded from a range with Quebec, Ontario, Kansas, Texas, and Georgia at its extremes; many of the records, however, are doubtless misidentifications.

Dr. E. D. Ball has kindly furnished me with a copy of his notes and sketch of the genitalia of Fitch's types, which are the basis for the present application of the name *vulgaris*.

C. fedusa new species. Frons perceptibly narrowed between eyes, but broadening gradually below that point almost to clypeus, the sides faintly incurved above and outcurved below. Ventral view of outer clasper of male as in Fig. 6, lateral lobe somewhat as in Fig. 14, but more rounded, apical hook well developed, both anteriorly and upwardly curved. Length, 3.75 mm. Holotype male and three rather teneral females, Eastern Branch, near Benning, D. C., Sept. 7, 1913, W. L. McAtee. Teneral male, St. Agnes, Sept. 2, on oak, Uhler Collection, (U. S. N. M.).

C. gedusa new species. Frons widest just below middle, the sides except for narrowing between eyes, almost evenly though slightly outcurved. Ventral view of outer clasper of male as in Fig. 18, lateral lobe similar to Fig. 13, but more rounded; apical hook, short, broad, acute, distinctly anteriorly and a little inferiorly curved. Length,

3.75 mm. Holotype male, Beltsville, Md., June 14, 1914, and four females, same locality, June 15, 1913, W. L. McAtee.

C. hedusa new species. Frons widest about two-thirds its length from vertex, the sides above that point a little incurved, below nearly straight. Ventral view of outer clasper of male as in Fig. 9, lateral lobe much as in *C. incisa* (Fig. 17), apical hook, small, short acute, directed inwardly, little curved. (Fig. 9). Length: 3–3.5 mm. Holotype and two paratype males, Beltsville, Md., May 17, 1914; other paratypes, same locality, May 28, 1916, on *Pinus virginiana;* Corner Conduit and Potomac Roads, Va., June 8, 1913, on *Pinus virginiana*, W. L. McAtee (McAtee); teneral male, St. Agnes, Sept. 22, Uhler Collection (U. S. N. M.).

C. kedusa new species. Frons rather wide, the greatest width about two-thirds its length from vertex, the sides smoothly incurved above and outcurved below this point. Ventral view of outer clasper of male as in Fig. 24, lateral lobe much like that of *C. incisa* (Fig. 17) but a little deeper and more narrowly rounded; apical hook stout, usually appearing dark and heavily chitinized, strongly curved both anteriorly and upwardly. Length: 4–5 mm. Holotype male, Forest Glen, Md., July 6, 1913, on *Morus rubra*, W. L. McAtee; paratypes: same data, and Odenton, Md., July 4, 1913; near Chevy Chase Lake, Md., July 6, 1913; Plummers Id., Md., July 19, 1914, W. L. McAtee; Glen Echo Md., June 17, July 1, 8, 1923, J. R. Malloch; Vietch to Torrison, Va., July 18, 1915; near Dead Run Swamp, Va., July 5, 1914; Virginia near Plummers Id., June 17, 1913, Mt. Vernon, Va., June 27, 1915, on *Salix babylonica*, W. L. McAtee. Also two specimens from the Uhler Collection, one labelled S. Ill. (U. S. N. M.); Lakehurst, N. J., July 26, H. B. Weiss, Ames, Iowa, July 1, 1894, St. Croix Fall, Wis., July 20, 1917, E. D. Ball (Ball).

C. ledusa new species. Frons of about same shape as in *C. kedusa*. Ventral view of outer clasper of male as in Fig. 15, lateral lobe much as in *C. vulgaris* (Fig. 13), apical hook small, incurved, acute. Length: 4–4.5 mm. Holotype male and paratypes, Manaos, Brazil, Miss H. B. Merrill (U. S. N. M.).

C. mallochi new species. Frons nearly of uniform width, widening slightly from vertex to a point three-fourths its length below, then slightly constricted before joining clypeus. Ventral and lateral views of outer clasper of male as in Fig. 22, apical hook long, directed nearly straight inwardly but slightly curved anteriorly. Length: 4–5.5 mm. Holotype male Glen Echo, Md., Aug. 10, 1923, J. R. Malloch; paratypes; same data; also Loui (Louisiana?) 2265, C. F. Baker (U. S. N. M.).

C. medusa new species. Frons narrowed between eyes the sides below almost evenly though slightly outcurved, widest about two-thirds length of front from vertex. Ventral view of outer clasper of male as in Fig. 20, lateral lobe much as in *C. vulgaris* (Fig. 13), apical hook, continuing the contour of the clasper, gradually narrowing, curved a little both inwardly and anteriorly, and pointed. Length: 4–4.5 mm.

Holotype male, La Ceiba, Honduras, F. J. Dyer; paratypes same locality and collector, Feb., March, April, 1916; Tegucigalpa, Honduras, April 5, 1917, F. J. Dyer; San Rafael, Vera Cruz, March, F. W. Goding (U. S. N. M.).

C. pedusa new species. Frons widest about two-thirds its length from vertex, rather straight-sided both above and below that point. Ventral view of outer clasper of male as in Fig. 19 the notch on inner side sometimes more open, lateral lobe much as in *C. incisa* (Fig. 17), apical hook arising wholly from inferior lamella of clasper, directed abruptly upwardly, and a little inwardly, and very sharp pointed. Length: 3.5 mm. Holotype male, Mexico 2154, C. F. Baker; paratypes, same data, and La Ceiba, Honduras, Feb. 19, 1916, F. J. Dyer (U. S. N. M.).

C. redusa new species. Frons widest about two-thirds of its length from vertex, the sides slightly incurved above that point, nearly straight and gradually convergent below. Ventral and lateral views of outer clasper of male about as in *C. vulgaris* (Fig. 13), apical hook as in *C. cedusa* (Fig. 23). Length: 4–5 mm. Holotype male and two females, Glen Echo, Md., Aug. 21, 1923, paratype males, same locality, July 30, 1922, J. R. Malloch; Dunn-Loring, Va., Aug. 30, 1916, W. L. McAtee.

C. tedusa new species. Frons widest about four-fifths its length from vertex, the sides well incurved above that point and nearly straight and convergent below. Ventral view of outer clasper of male as in Fig. 14; this aspect and the apical hook considerably like *C. vulgaris* (Fig. 13), but the lateral lobe broad and blunt instead of angulate. Length: 4–4.75 mm. Holotype male and two females, Hot Springs, Ark., 5. 9. 1916, E. H. Gibson. (Gibson).

C. vedusa new spceies. Frons widest about two-thirds its length from vertex, the sides gently incurved above and outcurved below that point. Ventral view of outer clasper of male as in Fig. 16, lateral lobe much as in *C. incisa* (Fig. 17) but not so high, apical hook slender, acute, strongly inwardly and downwardly curved. Length 4 mm. Holotype male, numbered 651, thought to be from Mexico (Ball.).

DESCRIBED SPECIES NOT SEEN.

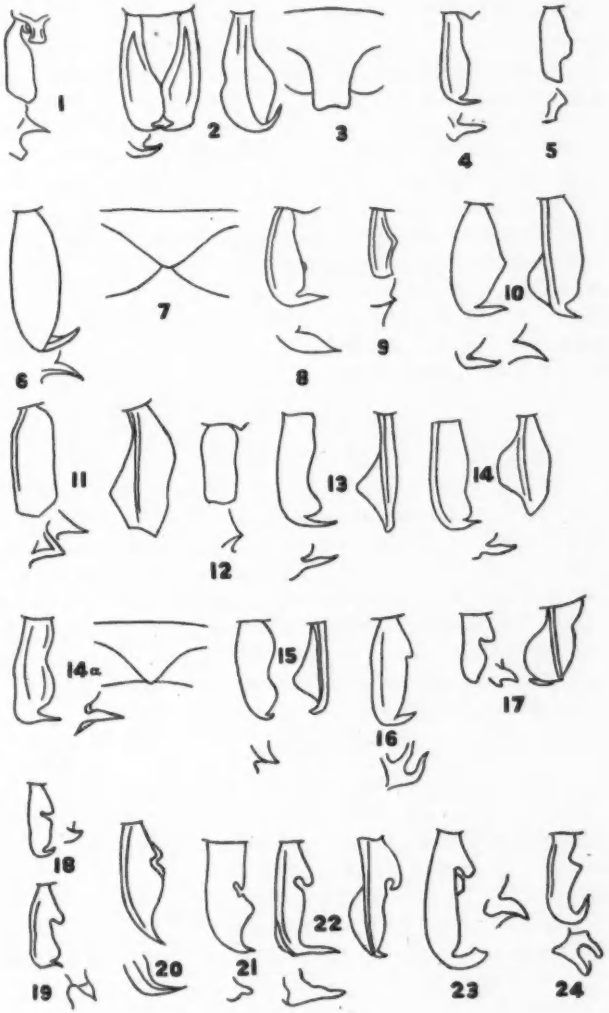
Cedusa venosa Fowler, Canon. Biol. Centr. Amer. Homop. 1, p. 112, Nov. 1904 [Mexico.]

EXPLANATION OF PLATE XXI.

The illustration of genitalia usually shown is a ventral view of right outer clasper of male and near each is a rear view of the apical hook of clasper. No further explanation is given unless there is a departure from this plan. The Figures are arranged in six series: 1, the only illustration of Cenchrea; 2–4, the *maculata* group; 5, *edentula;* 6–10, according to degree of angulation of inner margin; 11–23, according to the degree of emargination of the inner margin; and 24, the single representation of a distinct type of clasper.

Mr. J. R. Malloch has kindly redrawn the Figures from the writer's originals.

Fig. 1. Cenchrea uhleri.
Fig. 2. Cedusa maculata.
Fig. 3. Cedusa maculata, apical sternite of ♀.
Fig. 4. Cedusa flavida.
Fig. 5. Cedusa edentula.
Fig. 6. Cedusa fedusa.
Fig. 7. Cedusa fedusa, apical sternite of ♀.
Fig. 8. Cedusa inflata.
Fig. 9. Cedusa hedusa.
Fig. 10. Cedusa praecox; two shapes of apical hook shown, and at right a lateral view of clasper.
Fig. 11. Cedusa obscura; two shapes of apical hook shown, and at right a lateral view of clasper.
Fig. 12. Cedusa bedusa.
Fig. 13. Cedusa vulgaris; lateral view at right.
Fig. 14. Cedusa tedusa; lateral view at right.
Fig. 14a. Cedusa californica; apical sternite of ♀ at right.
Fig. 15. Cedusa ledusa; lateral view at right.
Fig. 16. Cedusa vedusa.
Fig. 17. Cedusa incisa, lateral view at right.
Fig. 18. Cedusa gedusa.
Fig. 19. Cedusa pedusa.
Fig. 20. Cedusa medusa.
Fig. 21. Cedusa funesta.
Fig. 22. Cedusa mallochi; lateral view at right.
Fig. 23. Cedusa cedusa.
Fig. 24. Cedusa kedusa.



W. L. McAtee

BIONOMICS OF HIPPODAMIA TRIDECEUM-PUNCTATA L.

CLIFFORD R. CUTRIGHT,
Ohio Agricultural Experiment Station, Wooster, Ohio.

In working with the Coccinellids, one will soon find that the larvæ of the different species are very hard to separate by a superficial examination. There is one species, however, to which this statement will not apply, this being the common 13-spotted Lady-bird beetle, *Hippodamia 13-punctata*. Due to its distinct coloring considerable interest in the species was aroused, and a brief review of the literature dealing with it was undertaken. This showed that while the species was mentioned frequently, and had been used as a subject in morphological studies, very little was known in regard to its life history.

HISTORICAL AND DISTRIBUTION.

Professor C. M. Weed, working at Ohio State University, in 1889, described the pupa and noted that the beetle was frequently found in aquatic situations. Mulsant has observed that in Europe it is frequently found on water plants infested with aphids. Gage, '20, has published a technical description of the larva and Professor Comstock has used the beetle in working out his system of wing venation.

It has a wide range, extending throughout the more northernly parts of the northern Hemisphere in Europe, Asia and North America.

LIFE HISTORY.

Individual larvæ and beetles were successfully reared under the inverted halves of petri dishes placed on a smooth surface. Aphids were fed to them daily, either attached to leaves or stems, or free from any plant tissue.

The eggs are found on the underside of leaves, usually in groups of from ten to forty. They are typically Coccinellid as to individuals and to groups, and bear no characters by which they can be distinguished from the eggs of other related species. In confinement, the females attach their eggs usually to the most convenient surface, but utilize shaded locations, if these are available. Under the usual summer temperatures eggs

hatch in three days, differences of from twelve to twenty-four hours from this period having been noted. Six to ten hours make up the hatching periods of large groups of eggs.

In hatching, the chorion cracks irregularly along the dorsal side, and the first part of the larva to appear and free itself is the prothorax. This is then bent backward and the head is released. By bending backward and forward, the legs and other thoracic segments are freed in order. This will have taken place in about ten minutes. The larva now rests for about an hour, then attaches its legs, and crawls out of the shell. After hatching, the larvæ spend from six to twelve hours grouped on the empty shells feeding on the inner and outer surfaces. At the end of this time they have become very black, and soon leave the shells in search of other food which they must have if they are to pass successfully the first instar. Four or five aphids will enable them to do this.

The larvæ are to be found in the same habitat as the aphids on which they feed. This species seems to be better adapted to prey on aphids on aquatic plants than other Coccinellids, at least they are found there in greater numbers. The larvæ are very active in their search for food, and after touching an aphid exhibit great excitement in securing it. A first instar larva will use several hours in devouring an adult aphid, while a mature larva will need only five to ten minutes for the same purpose.

The larvæ have four instars. A large number of larvæ were reared from hatching to pupation during July and August, and the following average lengths of the different instars were compiled from this source.

Instar	Average	Maximum	Minimum
First	3 Days	4 Days	2 Days
Second	1½ "	3 "	1 "
Third	2 "	3 "	1 "
Fourth	4½ "	6 "	3 "

When ready to moult the larva attaches itself by the tip of the abdomen and remains in this position for from one to six hours. The skin then cracks along the dorsal surface and the larva crawls out. The actual operation of moulting occupies only a very few minutes.

The feeding habits of the larvæ and the number of aphids that they destroy is of great interest from an economic standpoint. Seventeen larvæ were used to secure the feeding records, which are summarized as follows:

Instar	Average Number of Aphids Destroyed	Maximum	Minimum
First	17	38	7
Second	16	31	5
Third	32	56	10
Fourth	55	82	25

Average total—120.

This feeding record shows that the species may be of considerable economic importance in the immature stages though not to the degree that exists in some other Coccinellids. *Myzus persicæ* was the aphid used in feeding tests.

Near the end of the last larval instar, preparation for pupation is made by attaching the tip of the abdomen to any convenient surface. According to Gage, '20, attachment is secured by means of a sucking disk, which surrounds the anal opening and is formed by evaginations of the rectum. In from twelve to thirty-six hours the larval skin splits dorsally and the pupa by vigorous rocking motions succeeds in crowding it down about the tip of the abdomen, where it remains. The pupa at first is pale yellow, but in a few hours the characteristic black markings appear and are fully developed. The pupal period averages slightly over three days.

The adults emerge from the pupa case much as the larvæ do when moulting. They are pale yellow, but the black color pattern developes within the first hour. I have collected the beetles most commonly on crucifers, where they were feeding on *Myzus persicæ*, *Brevycorne brassicæ* and *Rhopalosiphum pseudobrassicæ*. On aquatic plants I have taken them feeding on *Myzus nymphalæ*.

In hunting for food the adults are vigorous and more effective than the larvæ. They use their eyes, and have frequently been seen to pursue and capture aphids which were tumbling down the sloping surface of a leaf.

Feeding records were taken separately for males and females, each lot being carried over a ten day period, with the following results.

The males averaged a destruction of twenty aphids per day, while the females destroyed forty-two, thus giving an average of over thirty per day for the two sexes. This average is not as high as has been recorded for *Hippodamia convergens*, or *Coccinella 9-notata*, but exceeds the records of *Hippodamia parenthesis* and *Adalia bi-punctata*. There is no doubt that where food is abundant in the field, the females in particular, will exceed the record given above.

The pre-oviposition period was observed in only a few instances, where it varied from five to eight days. It is thought that a scarcity of food may have something to do with the length of these periods.

After females have been fertilized, fertile eggs will be laid for about three weeks, at the end of this time the eggs become sterile. If a male is again introduced the fertility of the eggs will be restored in from three to six days. Females will oviposit without having been fertilized, but the production of eggs is much less, scarcely a fourth of the usual number.

Egg laying records were taken for five females which averaged four hundred and seven eggs each for the entire oviposition period.

There was a definite effect on egg production due to varying amounts of food. When only five to ten aphids were available daily, as food, neither copulation nor egg laying occurred. If fifty or more aphids were at hand, egg laying proceeded at the maximum rate. By varying the amount of food between these limits, a proportionate decrease or increase in egg laying was observed. With abundant food, the first oviposition of the year will occur in late April or May and will continue until October, unless interrupted by food shortage or very cold weather.

In the laboratory adults lived through periods varying from two to eight weeks in length, the average being about thirty days, if sufficient food was supplied. Beetles of the summer generations that are free will undoubtedly live through a longer period. The hibernating adults must live at least seven months, and probably live longer. A period from egg to egg, twenty-five days indicates that there could be four or five generations during

the summer. However, field observations show that there are rarely more than three.

Individuals of the last two generations overwinter and are to be found in grass clumps and under refuse near old aphid-infested plants.

DESCRIPTIONS.

The eggs are typically Coccinellid in size, color, shape and grouping. They possess no distinctive features. The larvæ of the early instars are easily recognized in the field by their black and white color. Since a complete description of the fourth instar larva has been published, (Gage, '20), the early stages will not be treated technically here. Weed's description of the pupa is correct for the autumnal forms, but those of the summer are lighter in color and have almost the same color pattern as *Hippodamia convergens*. The most convenient description of the adult is in "The Coleoptera of Indiana."

NATURAL ENEMIES.

Very rarely an adult may be found parasitized by the braconid *Dinocampus americanus*, Riley, which is common on other Coccinellids. The larvæ have been found attacked by the same chalcids that are parasitic upon the immature stages of other species, namely, *Homalatylus flaminus*, *Pachneuron aphidiorum*, and *Pachneuron* sp. I have found no parasites on either eggs or pupæ. These stages, however, are frequently attacked by the adults and larvæ of all the Coccinellids, in case other food is not abundant.

From the limited literature and from observation, I believe that there is no disease of any importance attacking the beetle.

BIBLIOGRAPHY.

Comstock, J. H. 1918. The Wings of Insects, p. 297.

Gage, J. H. 1920. The Larvae of the Coccinellidae. Ill. Biological Monograph, October, 1920.

Riley, C. V. 1868. First Report of the State Entomologist of Mo.

Thomas, Cyrus. 1877. Sixth Report of the State Entomologist of Ill.

Weed, C. H. 1889. Technical Series, Bull. No. 1, Ohio Agr. Exp. Station.

A REVIEW OF THE GENUS CHELINIDEA (HEMIPTERA-HETEROPTERA) WITH BIOLOGICAL DATA.*

By JOHN C. HAMLIN,
Officer-in-Charge, Prickly-pear Investigations,
Commonwealth Prickly-pear Board.

INTRODUCTION.

For the past three years the writer has been in intimate contact with the insects affecting cactus in North America. During the first two years of this period the writer's work was seeking, collecting, rearing free from parasites, and shipping cactus insects to Australia in furtherance of the Australian Commonwealth's project designed to control the prickly-pear pest on that continent by natural agencies. The cactus bugs of the genus *Chelinidea* are among the more important insect enemies of prickly-pear and received constant attention during that period, both in the field and in the laboratory. During the past year opportunity was provided to observe the actions of these insects in Queensland, Australia.

Early in the prosecution of the work an undescribed species was found in Texas, and during 1922 another new species was taken in the State of Sonora, Mexico. During 1923 I published descriptions of these species and a variety of a previously described species. Subsequent to the publication of this paper I had an opportunity to review the writings of Mr. W. L. McAtee on the genus upon my return to the United States recently.

It has been deemed advisable to record in a comprehensive paper the result of my taxonomic studies, rearing work, and field observations. Because of the restricted distribution of the Australian journal in which the new species were described, I am including the original descriptions herein.

This treatment of the genus is based upon studies made by the writer in Florida, Texas, and Arizona, in the United States, and in the Mexican States of Tamaulipas, Nuevo Leon,

* Dr. W. D. Hunter is largely responsible for the undertaking of this study. To him the writer is deeply indebted for kindly support and helpful criticisms drawn from his extended experience with these insects.

Coahuila, San Luis Potosi, Mexico, Morelos, Federal District, and Sonora. In addition the United States National Museum material has been examined.

With regard to synonomy, only the references to original descriptions and synonyms arising subsequent to the publication of Van Duzee's catalogue of hemiptera, are included.

The distribution of species as here given applies only to natural occurrence. It should be stated, however, that four representatives are now established in laboratories in New South Wales and Queensland, Australia, and will probably be liberated in those States soon. These forms are: *Chelinidea vittiger* subsp. *aequoris* McAtee, *C. v. aequoris* var. *artuatra* McAtee, *C. tabulata* (Burmeister), and *C. canyona* Hamlin.

Genus **Chelinidea** Uhler.

Haplotype vittiger Uhler. Proc. Ent. Soc. Phila., v. 2, No. 3, p. 365-366, 1863.

Uhler erected the genus Chelinidea upon a knowledge of a dark form of one species which was known to him. Studies of the various forms show that the generic characters originally outlined include a number of points which apply only to the form which he named *C. vittiger*. The species form a natural group, and, to include the present known species, the generic limitations must be expanded as follows:

Allied by general form to *Anasa*, but somewhat broader, oval. Head subequal to or two-thirds length of pronotum, roughly cylindrical, gently curved dorsally to the posterior margin; tylus appearing conical from above, its anterior carina perpendicular; juga acutely pointed and more or less attenuated; eyes subcircular, prominent, noticeably nearer base of head than to antennal attachment; antennæ four-jointed with the three basal joints prismatic; basal segment flattened and crested on inner edge, second and third joints subequal, distal joint rounded and tapered toward either extremity; genæ emarginated beneath at middle of the bucculæ; bucculæ about one-third length of the basal segment of rostrum, broad, truncated before, rounded and acute behind; rostrum just attaining the abdomen, proximal joint thick, cylindrical, slightly longer than the head, the second joint more slender and subequal in length to the first, the third about half the length of the fourth, the fourth about two-thirds the length of the second; labrum nearly as long as basal segment of the rostrum. Pronotum nearly twice as wide as long, subhexagonal, the latero-posterior sides but bluntly and briefly defined, forming very obtuse angles with the posterior margin; all margins, except the anterior one, carinated and more or less elevated, the anterior margin produced over the head to form a narrow collar with or without lateral teeth; humeral angles somewhat obscure. Pectus with a broad sulcus to receive the rostrum. Veins of the corium conspicuous, prominent, the middle one forked at the end, forming an acutely triangular cell; costal margin acutely elevated; nervures of membrane

numerous, forked, ramose. Connexivum bent upward and usually distinctly dilated. Penultimate ventral segment of female transversely incised near base, and then divided into two conspicuous lamellæ; genital segment triangularly emarginate, the pieces each side sub-acute at tip. Posterior femora heavy, cylindrical, scarcely curved, bearing two rows of slender teeth on under surface of distal half of segment, anterior and middle femora fitted with smaller and fewer teeth; tibia prismatic, edges carinated or crested.

KEY TO SPECIES.

1. Pronotal lateral margins carinate; anterior pronotal teeth absent or obscure; connexivum no more than moderately dilated; antennæ and tibiæ regularly angular.....2
   Pronotum with lateral margins produced into distinct, though slight, crests; anterior teeth distinct; connexivum much dilated; antennæ and tibiæ with edges flattened and elevated.....3
2. Medium size, robust; from above, juga barely exceeding tylus; pronotal teeth small or lacking; connexivum moderately dilated; posterior surface of front femora with only 2 or 3 teeth, distally.....*C. vittiger* Uhler
   Small, slender; juga slightly exceeded by tylus; pronotal teeth absent; connexivum very slightly dilated; fore femora with from 3 to 6 teeth in two rows, distally.....*C. hunteri* Hamlin
3. Juga produced well beyond tylus; front femora with from 5 to 9 teeth in two rows, distally.....*C. tabulata* (Burm.)
   Juga just attaining tip of tylus or very slightly exceeded by it; front femora with only 2 or 3 teeth; lateral pronotal margins, edges of antennæ and tibiæ more sharply produced than in preceding.....*C. canyona* Hamlin

Chelinidea vittiger Subsp. **vittiger** Uhler.

Chelinidea vittiger Uhler. Proc. Ent. Soc. Phila., 2, p. 366, 1863.

Uhler's description was based upon specimens collected in Utah and at Fort Benton, Montana. McAtee (1919:p. 11) has selected the latter place as the type locality of the species. This writer divided the species into subspecies on the degree of carination of the pronotum and the prominence of the anterior, lateral pronotal tubercles. Each subspecies has a color variety. My own studies of the group, culminating in an examination of McAtee's types, confirm this treatment of the species.

DESCRIPTION OF ADULT.

Head two-thirds length of pronotum; ocelli slightly nearer to eyes than to anterior teeth of pronotum; juga abruptly pointed with outer margins much curved, giving the appearance of being curved inward toward the tylus; juga barely exceeding the tylus. Antennæ regularly angular, except rounded distal segment. Pronotum slightly convexed, lateral margins merely carinate and ending anteriorly in obscure, blunt teeth. Connexivum moderately dilated. Under surface of fore femora bearing distally two or three small teeth. Tibiæ triangular with superior edges carinate. Seventh ventral segment of female medianly cleft to three-fourths of its width, the edges of the incision prominently rounded and overlapping, margins either side of incision broadly concave.

Color brownish-black with yellow markings. Head black with a yellow vitta on the tylus extending to the base of the head, and an indistinct yellow vitta on lateral edges interrupted by the eyes; antennæ blackish; bucculæ and basal joint of beak, yellow; pronotum yellow except for transverse black vitta just before posterior margin which hardly reaches the humeri, and a blackish area just behind the insertion of the head. Scutellum and coriaceous portion of hemelytra blackish except for the lateral edges of the hemelytra and the veins, pale; membranous portion blackish-bronze; beneath rich yellow with legs and portion of pectus between coxæ, blackish.

Length 10–13 mm.; humeral breadth 3.5–5.5 mm.

DISTRIBUTION.

McAtee (1919:p. 11) records the subspecies as occurring in Wyoming, Colorado, Utah, New Mexico, Arizona, and California. Van Duzee* recorded Uhler's species from Idaho, and it undoubtedly belongs to this subspecies.

Chelinidea vittiger Subsp. **vittiger var. artuflava** McAtee.

Chelinidea v. vittiger var. *artuflava* McAtee. Bull. Brooklyn Ent. Soc., 14, p. 11, 1919.

This color variety has the antennæ and legs lighter brown or yellow, while the pronotum is entirely yellow or shows only the posterior vitta. Its range includes California, Arizona, New Mexico, and Texas.

Neither form of this subspecies has been dealt with by the writer in the field or in the rearing work, my experience having been with the two forms of the succeeding subspecies.

Chelinidea vittiger Subsp. **aequoris** McAtee.

Chelinidea vittiger subsp. *aequoris* McAtee. Bull. Brooklyn Ent. Soc., 14, p. 12, 1919.

Chelinidea vittigera var. *texana* Hamlin. Proc. Royal Soc. Queensland, Vol. 35, p. 45, 1923.

This subspecies is somewhat less robust and may be distinguished by the very low pronotal margins. Anteriorly the lateral margins of the pronotum are scarcely carinate, and the anterior, lateral teeth absent or barely indicated. Typically, the color is uniformly dirty brownish-yellow except the dark eyes, the smoky-black tip of the beak, and the greenish-black membrane of the hemelytra.

Length, 10–13 mm.; humeral breadth, 3–4.5 mm.

---

* Van Duzee, E. P. Cat. Hemip. of Amer. North of Mexico. Univ. of Calif. Pub., Vol. II, pp. 1-902, 1917.

THE IMMATURE STAGES.

The Egg.—Length, 1.4 mm.; width, 0.8 mm. Dark brown, opaque, very finely and uniformly punctured, mottled with a whitish exudation. Ellipsoidal; lid sub-dorsal, large elliptical. Normally placed longitudinally on under side of spines about 0.1 mm. apart. Rows of eggs varying from 3 to 16 eggs each. Attachment to spines very weak. Incubation period, 9 to 12 days.

First Instar.—Length, 2 mm. Newly hatched nymphs are bright red with abdomen very pale yellow. They soon become black with abdomen yellowish-green. Antennæ 4-jointed; basal joint flattened on inner side; second joint slender, triangular and sub-equal in length to third joint; third segment swollen, triangular; distal joint half the length of the third; second and third joints fitted distally with short spines. Beak reaching middle of abdomen. Abdomen much convexed dorsally, with callosity and margins rust-red. Juga acutely pointed, extending far beyond tylus and bent inward. Duration of instar, 7 days.

Second Instar.—Length, 4 mm. Very slight changes from first instar. Color blackish-brown with abdomen pea-green except callosity and margins, rust-red. Distal spines of second and third antennal joints more distinct. Beak extending only to third abdominal segment. Duration of instar, 5 days.

Third Instar.—Length, 5.5 mm. Prothorax changing to greenish; the two transverse brown slits of the abdominal callosity very conspicuous; distal half of distal antennal joint, light brown. Antennal spines more distinct as is the raised callosity on the abdomen; antennæ more distinctly prismatic. Duration of instar, 7 days.

Fourth Instar.—Length, 6.5 mm. Head, three basal antennal joints, two distal joints of beak, tibiæ, and tarsi, brownish-black; distal half of antennal club, orange; abdomen, darker green. Callosity of abdomen prominent, slits edged with black. No change in antennal spines. Duration of instar, 15 days.

Fifth instar.—Length, 9.0 mm. Color forms more distinct. The one is shining black, except abdomen and tips of antennæ; abdomen, greenish-black; tips of antennæ, orange. The other has the head black; antennæ reddish-brown with the tips paler; distal segment of beak, black; legs reddish-brown except femora, pale yellow, thorax with wing-pads yellowish-green; abdomen dark green with slits of callosity, black. A third form has the abdomen light reddish-brown in color, with other parts varying between the extremes described above. No change in antennal spines. Juga more acutely pointed and not so much incurved. Abbreviated wing-pads present and extending over the anterior two abdominal segments. Thorax much widened, altering the appearance greatly as in all previous instars the thorax was much narrower than the abdomen. Duration of instar, 18 days.

The above recorded periods for the fourth and fifth instars were obtained at Uvalde, Texas, during September and early October. During the summer months these intervals would very likely be somewhat shorter.

SEASONAL HISTORY.

This subspecies passes the winter in the adult condition, and resumes activity early in the spring. At Brownsville, Texas, the writer has noted second instar nymphs in the field by the middle of March, indicating that mating and oviposition occurred some three to four weeks earlier. Near Victoria, Texas, first instar nymphs were observed during the first half of April, while at Uvalde, Texas, the first stage nymphs appear about the first of May. Oviposition by a given lot of adults extends over several weeks. This fact coupled with the unequal rate of development, even under identical conditions, of the individuals of a given generation makes for a confusion of generations. Such merging of broods obscures the number of generations produced during the year, but it is safe to estimate from four to five broods yearly.

HABITS.

This form is gregarious in all the nymphal stages, as are the adults to a less marked extent. During hibernation the adults are clustered quite close together.

When newly transformed the adults continue to feed heavily for a time and do not mate to any extent during this period. Later, mating and oviposition are their principal activities, and the amount of feeding is very small.

Both adults and nymphs have the habit of running to that side of the joint away from the observer.

During oviposition the female hangs from the spine by her legs, usually using only the second and third pairs.

When approached the bugs discharge liquid excrement much more profusely. This liquid, upon drying, leaves very characteristic whitish splotches on the plant.

FOOD PLANTS.

This variety has been found feeding as nymphs and adults upon the various Opuntias, tasajillo (*Opuntia leptocaulis*), and *Echinocereus* sp. The eggs have also been observed attached to spines of Opuntias and tasajillo. In regions where this *Echinocereus* commonly occurs along with prickly-pear, the former is a favored hibernating place. By far the most common food plants are the Opuntias.

DISTRIBUTION.

It is this form of *Chelinidea* which is the common cactus bug of Texas. In that state the writer has taken it at Victoria, Kingsville, Brownsville, Laredo, San Antonio, Uvalde, La Pryor, Con Can and Eagle Pass. In Mexico I have taken it in the country just south of Piedras Negras, Coahuila, and at Monterrey, Nuevo Leon.

McAtee's records of its occurrence are all from Texas.

NATURAL ENEMIES.

The tachinid parasite, *Trichopoda pennipes* Fabricius; while not so common as in Florida, has been found to occur in Texas as a parasite of this cactus bug.

Phidippus workmani Peckham and *P. californicus* Peckham are spiders which are very prevalent on cactus in Texas. Both of them have been observed to destroy many of the nymphs.

Monomorium minimum Buckley has been found preying upon the eggs of this subspecies at Uvalde, Texas.

Chelinidea vittiger Subsp. **aequoris var. artuatra** McAtee.

Chelinidea v. vittiger var. *artuatra* McAtee. Bull. Brooklyn Ent. Soc., 14, p. 12, 1919.

This variety approaches *C. vittiger* subsp. *vittiger* Uhler in color. Its color differs from Uhler's form in lacking the anterior black area of the pronotum and the black pectoral area between the coxæ. In some specimens the pronotum is entirely yellow.

SEASONAL HISTORY.

The representatives of this variety dealt with hereunder have all come from Gainesville, Florida. Knowledge of several factors gives an excellent indication of the seasonal history despite the fact that the variety has not been reared continuously in its native habitat. The seasonal history indicated below is based upon observations made at Gainesville on February 1, April 1, June 15, and December 1, together with a knowledge of the seasonal cycle of its Texas relative.

Hibernation extends from the first part of December to the middle of March. During this period the adults cluster together on the under sides of joints of the prostrate-growing prickly-pears of northern Florida. During warm periods in winter

they appear on the upper surface of the plant and feed to a slight extent. The adults emerge from hibernation during the latter part of February and begin feeding more steadily. Oviposition begins about the first of March. The last summer generation reaches maturity during the first part of December. There are, then, about four broods annually in the vicinity of Gainesville, Florida.

HABITS.

The observed habits of this variety do not differ from those of *C. vittiger* subsp. *aequoris* McAtee, except that it is the slowest of any of the genus to take flight when disturbed.

FOOD PLANTS.

At Gainesville, the only locality in Florida where I have taken *Chelinidea v. aequoris* var. *artuatra* McAtee, the insect has been found feeding in the field only upon *Opuntia lata* Small. In a yard it was found on *Opuntia dillenii*, Mr. D. C. Parman, Bureau of Entomology, sent me specimens of this insect from Franklin, Tennessee, which he stated were taken on an Opuntia very similar to *O. lata*, and which I suspect is *O. pollardi*, Britton & Rose.

The above observations are not to be construed as meaning that this insect is restricted to the species of prickly-pear mentioned. When breeding *Chelinidea v. aequoris* var. *artuatra* McAtee, at Miami, Florida, where it does not occur naturally, it prospered on *Opuntia austrina* and *O. drummondii*. Again, when rearing the species in Texas and Australia, it has been found to live upon *Opuntia lindheimeri* and *O. engelmanni* in the former locality and upon *O. inermis*, *O. stricta*, and *O. megacantha* in the latter place. It is true, however, that the species does not prosper upon the Texan and Australian Opuntias to the extent that it does upon the Florida prickly-pears.

DISTRIBUTION.

McAtee (1919:pp.12–13) recorded this form from North Carolina, Alabama, and Texas. Uhler's specimens from Virginia and Louisiana also belong here. Van Duzee records a Chelinidea from Georgia which doubtless is this variety. The writer has taken it at Gainesville, Florida, and has received others from Franklin, Tennessee, through Mr. D. C. Parman.

NATURAL ENEMIES.

Trichopoda pennipes Fabricius, the tachinid fly which parasitizes a large number of heteropterous insects, has been found as a somewhat abundant parasite of *Chelinidea v. aequoris* var. *artuatra* McAtee, at Gainesville, Florida.

Chelinidea hunteri Hamlin.

Chelinidea hunteri Hamlin. Proc. Royal Soc. Queensland, Vol. 35, p. 43, 1923.

Head subequal in length to pronotum, ocelli nearer to eyes than to pronotal collar, juga rather abruptly pointed and a very little exceeded by the tylus. Three basal joints of antennæ regularly angular. Pronotum more convexed than in the preceding species, lateral margins nearly straight from humeral angles to collar, anterior margin without teeth. Connexivum little dilated, extending as only a narrow edge beyond the hemelytra; hemelytra and connexivum forming straight parallel lines. Under surface of fore femora with from three to six teeth distally, arranged in two rows. Tibiæ merely carinate.

Ground color faded yellow; head dark brownish or fuliginous with a paler, indistinct vitta extending from over the tylus to the base of the head, antennæ fuliginous except distal joint; pronotum with fuliginous transverse vittæ near front and rear margins; coreaceous portion of hemelytra mottled with rusty brown and smoky areas, the veins pale and bordered by thin lines of black; membrane blackish-bronze; beneath, uniform greenish-yellow with legs a shade darker, and tip of rostrum, piceus.

Length 9.5–10.5 mm.; humeral breadth 3.5–4 mm.

This species was described from four male specimens taken by the writer on a cylindropuntia of the *Imbricatæ* series at Ranchita near Hermosillo, Sonora, Mexico, on August 7, 1922. The existence of the species had been previously indicated as occurring on similar plants (*Opuntia arbuscula*, *O. versicolor*, and *O. fulgida*) at Tucson, Arizona, by Hunter, Pratt and Mitchell.* A specimen in the U. S. National Museum from Tucson, Arizona, belongs to this species.

Type material is deposited in the National Museum under U. S. N. M. type number 26825.

Chelinidea hunteri is the only species of the genus that has not been collected and reared for shipment to Australia and no further data are now available.

* The principal Cactus Insects of the United States, by Hunter, Pratt and Mitchell, (Bull. 113, Bur. Ent., U. S. D. A., 1912).

Chelinidea tabulata (Burmeister).

Gonocerus tabulatus Burmeister, Handb. d. Ent., II, p. 311, 1834.

Head sub-equal in length to pronotum; ocelli slightly nearer to points of pronotal teeth than to eyes; juga regularly conical, acutely pointed, and produced well beyond the tylus. Pronotum hardly convexed transversely; the lateral carinæ slightly raised, and produced anteriorly along the base of the head as two distinct, acute teeth; humeral angles more marked than in *C. v. vittiger* Uhler. Connexivum greatly dilated and obliquely directed upward. Under surface of front femora bearing distally a double row of teeth, decreasing in prominence proximally, and totalling from five to nine teeth. Tibiæ triangular with all edges distinctly raised; hind tibiæ with the two outer edges distinctly crested. Seventh ventral segment of female medianly cleft to two-thirds of its width, the edges of the incision straight, and barely overlapping; margins either side of notch nearly rectilinear.

Color above yellowish-brown to dark brownish. Posterior and lateral edges of pronotum, scutellum and membranous portion of hemelytra, smoky black; veins of coreaceous portion of hemelytra pale; connexivum smoky-black with segments indicated by pale lines. Beneath, yellowish except pectus and bases of legs, smoky, venter sometimes splotched with brownish. Some specimens entirely smoky black beneath.

Length, 10–15 mm.; humeral breadth 3.5–5 mm.

THE IMMATURE STAGES.

The Egg.—Length, 1.4 mm.; width, 0.85 mm. Dark brown, polished, densely and finely punctured with great uniformity. Ellipsoidal; lid sub-dorsal, elliptical. Placed about 0.2 mm. apart on under surface of spines in subrectilinear rows. The number in a row varies from two to twelve. Attached surface curved to fit spine, adding strength to the attachment. Incubation period, 9 to 13 days.

THE NYMPHAL STAGES.

First instar.—Length, 2 mm. Newly hatched nymphs are carmine colored except the abdomen which is gray, approaching frosted white. Soon they become shining black with abdomen frosted gray. Antennæ 4-segmented; proximal joint flattened on inner side; second segment about three-fourths as long as the third; third segment somewhat thicker than second; club short; second and third joints fitted distally with short spines. Beak reaching middle of the abdomen. Abdomen rather flat dorsally, callosity indistinct. Juga acutely pointed, not incurved, and barely attaining tip of the tylus. Duration of instar, 6 days.

Second Instar.—Length, 4.25 mm. Straw colored to reddish-brown except the abdomen pale dull green. Antennal spines somewhat more distinct; third joint only slightly inflated; distal joint acutely pointed. Beak hardly reaching third abdominal segment; tip black. Callosity

indistinct. Juga as before except that they now greatly exceed the tylus. Duration of instar, 7 days.

Third Instar.—Length, 5.5 mm. Changes few. Antennal spines very distinct. Duration of instar 6 days.

Fourth Instar.—Length, 6.5 mm. General color as before; thorax and abdomen punctured with very fine black specks. Second and especially the third antennal joints noticeably widened; no change in spines. Abdomen much broadened; flattened dorsally; callosity indistinct with small, yellowish, transverse slits inconspicuous. Duration of instar, 16 days.

Fifth Instar.—Length, 10.5 mm. Head, antennæ, and legs reddish-brown; thorax below with lines of black above coxæ; thorax above and abdomen, rich green bordered with blackish; abdomen below, grayish-green. No change in antennal spines. No change in juga. Abbreviated wing pads extending over the anterior two abdominal segments. Appearance of nymph greatly altered by the thorax becoming much widened whereas in previous stages it was much narrower than the abdomen. Duration of instar, 22 days.

The records of development through the fourth and fifth instars were obtained during September and October, so it is quite possible that the length of these stages is longer than they would be during midsummer. These records were made at Uvalde, Texas.

SEASONAL HISTORY.

The broods of this species overlap as do those of *C. v. aequoris* McAtee. In the region about Brownsville, Texas, the species spends but a brief period of the year in sporadic hibernation beneath rubbish at the bases of cactus plants. Since, in midsummer, a brood develops from egg deposition to adult emergence in from seven to nine weeks, there are three or possibly four broods per year at Uvalde, Texas. In the lower Rio Grande Valley there are probably five generations annually. About the middle of November this species was found in all stages in the vicinity of Mexico City.

HABITS.

This species is not gregarious either as nymphs or as adults. The nymphs are usually found feeding singly near an areole, but sometimes two or three nymphs are observed feeding around the same areole.

The adults and nymphs seem to be somewhat more sluggish crawlers than are those of *C. v. aequoris* McAtee. Except that

the adults take flight more quickly, they react to an approach just as do the nymphs and adults of *C. v. aequoris* McAtee.

FOOD PLANTS.

The writer has observed this species to feed upon cacti of the *Imbricatæ* series, as well as on the Opuntias.

DISTRIBUTION.

Chelinidea tabulata (Burmeister) is a Mexican species which extends its range into Texas. In Mexico I have taken it at Monterrey, N. L.; San Luis Potosi, S. L. P.; San Juan de Teotihuacan, Mex.; Tlalpam and Tepepam, D. F.; and Cuernavaca, Mor. Hunter et al (*) recorded it from the following Mexican localities: Durango, Aguascalientes, and Victoria. In Texas it occurs from Austin, southward and westward. In that state it is not so abundant as *C. v. aequoris* McAtee, except in the lower Rio Grande Valley region, where it is the dominant form of the genus. Van Duzee's catalogue of hemiptera recorded it also from Utah, Colorado, and California. Hunter et al.* included Arizona in its range.

NATURAL ENEMIES.

The only enemies of the species which came under observation are the two spiders mentioned as preying upon the nymphs of *C. v. aequoris* McAtee.

Chelinidea canyona Hamlin.

Chelinidea canyona Hamlin. Proc. Royal Soc. Queensland, Vol. 35, p. 44, 1923.

Head and pronotum sub-equal in length; ocelli nearer to extremities of pronotal teeth than to eyes; juga rather abruptly pointed and just attaining the tip of the tylus or very slightly exceeded by it. Antennal margins much elevated and flattened. Pronotum appearing slightly concave; the lateral margins elevated, forming distinct, laterally-compressed crests which are curved upward; anterior margin with a strong, acutely pointed tooth on either side. Connexivum greatly dilated and inclined upward. Under surface of fore femora bearing distally two or three small teeth. Tibiæ triangular with all edges prominently elevated; hind tibiæ with the two outer edges almost foliaceous. Penultimate ventral segment of female medianly cleft to two-thirds of its width, the edges of the incision slightly rounded and barely overlapping; margins either side of the notch very slightly concave.

* The principal Cactus Insects of the United States, by Hunter, Pratt and Mitchell, (Bull. 113, Bur. Ent., U. S. D. A., 1912).

Color above rusty-brown with darker markings. Head brown with a paler vitta on tylus, extending to base of the head and bordered by shining black; pronotum with a wide border of black just before the posterior margin, and very narrow ones along the lateral margins; hemelytra with three dark bluish vittæ each, one along the outer margin and two oblique ones converging with the first proximally; membrane black; connexivum dark with segments indicated by pale lines; beneath, yellowish except pectus, bases of legs, and tip of rostrum, shining black; legs brownish-yellow except coxæ and bases of femora.

Length, 11–14 mm.; humeral breadth, 4–4.5 mm.

Type and three paratypes deposited in the National Museum under U. S. N. M. type number 26826.

THE IMMATURE STAGES.

The Egg.—Length, 1.6 mm.; width, 0.8 mm. Light brown, very highly polished, with uniformly dense punctures delicately indicated. Ellipsoidal; lid subdorsal, broadly elliptical. Placed about 0.4 mm. apart on the under side of the spines. They are more scattered than are the eggs of *C. v. æquoris* McAtee and *C. tabulata* (Burmeister). The number placed together is from two to ten, in which case they are in a row. Attached surface flat; attachment weak. Incubation period, 11 days.

THE NYMPHAL STAGES.

First Instar.—Length, 2.5 mm. When first hatched the nymphs have the head, thorax and both extremities of the legs and antennæ brown; the middle portions of the legs and antennæ, pale brown; and the abdomen, bluish-gray. Later they become entirely brown except the abdomen which remains unchanged. Antennæ 4-jointed; basal three segments triangular and heavy, the third being larger than the others; third joint about one-fourth longer than the second; club short; second and third segments with short spines distally. Beak attaining second segment of abdomen only. Abdomen flattened dorsally; callosity present. Juga acutely pointed and hardly exceeding the tylus. Duration of instar, 7 days.

Second Instar.—Length, 4.5 mm. Changes few. Head and thorax brown; antennæ and legs pale except the tarsi, black; abdomen pale dull green. Third segment of antennæ slightly enlarged; second and third joints sub-equal in length. Duration of instar, 9 days.

Third Instar.—Length, 6 mm. Differences are in color. Head, reddish-brown; thorax greenish with black lines on either side just above coxæ; legs and antennæ pale yellowish; tip of beak and tarsi, black; abdomen pale dull green with two dorsal, yellow slits inconspicuous, and margins sawlike and blackened. Duration of instar, 6 days.

Fourth Instar.—Length, 6.75 mm. General color unchanged; thorax and abdomen finely and densely punctured with blackish edges of abdomen rust-red with black dots at intervals. Spines of second and third antennal joints short and relatively inconspicuous; third joint but little wider than the two basal ones. Duration of instar, 16 days.

Fifth Instar.—Length, 10 mm. Head fuliginous brown, antennæ dull brown; thorax green with a pale brownish overcast; legs yellow with tarsi, black; abdomen green, edged with black; slits of abdominal callosity, light brownish; beneath grayish-green except black lines above coxæ on thorax. No change in antennal spines. Thorax much broadened greatly altering appearance of the nymph. Duration of instar, 25 days.

The length of the fourth and fifth instars is probably much shorter in midsummer than is indicated above since these records were made during September and October. The rearing recorded was carried out at Uvalde, Texas.

SEASONAL HISTORY.

The summer season in the canyon country just north of Uvalde, Texas, is about a month shorter than at Uvalde. Observations indicate that only three generations are produced yearly. The first brood reaches maturity the latter part of June or the first of July. The second generation attains the adult condition during late August or about the first of September, while the last brood appears as adults during the first part of November. During the winter these bugs hibernate in sheltered places at the base of the cactus plant.

HABITS.

With the exception of *C. v. aequoris* var. *artuatra* McAtee, this species is the slowest of any of the genus to take flight when disturbed.

FOOD PLANTS.

This species has been found only upon the prickly-pears of the canyon region and to a lesser extent on an *Echinocereus*. They have been reared without difficulty upon the Opuntias of the Uvalde region which are not available in the canyon country. The species has also propagated readily upon the Australian prickly-pears, especially on those forms known there as *Opuntia inermis* and *O. stricta*.

DISTRIBUTION.

This species has not been found by the writer except in the canyons of the Guadalupe Mountains, north of Uvalde, Texas. Even in this canyon region the species does not occur in the lowlands, but appears to be limited to the hillsides. Specimens in the United States National Museum collected in the Chisos Mountains of Brewster County, Texas, and from

Devil's River, Texas, have also been found to belong to this species.

NATURAL ENEMIES.

Trichopoda pennipes Fabricius has been found parasitizing this species to a greater extent than any of the other Texan Chelinideas.

SPECIALIZATIONS TO CACTUS.

The adult Chelinideas, though potentially strong fliers as is occasionally exhibited, use their wings more infrequently than would be thought. With few exceptions the cactus-feeding insects are sluggish. This condition appears to be due to their life on plants which afford a high degree of protection because of their many spines.

The manner in which the eggs of these bugs are deposited is the best indication of long association with the cactus plant. The majority of phytophagous heteropterous insects deposit their eggs in clusters. The eggs of the various *Chelinidea* bugs are invariably placed longitudinally on the lower sides of the cactus spines. It would seem, then, since the spines are highly modified parts of the plant, that oviposition on such parts indicates an adaptation of no little moment.

CHARACTER OF INJURY BY CHELINIDEA SPP.

The insects of this genus feed by inserting the beak deeply into the succulent cactus plant and sucking the juices therefrom. The feeding marks appear as small, circular pale areas on the joints and are very conspicuous. The size of the spots is indicative of the stage of the insect which caused them. When the bugs are numerous these discolored areas soon coalesce, giving to such parts a yellowish, deadened appearance. When the joints have attained this condition the bugs migrate to fresh food. The attachment of such joints to the plant is rendered very weak and they usually fall to the ground where they dry out completely or are destroyed by various scavenging insects (*Volucella esuriens* Fabricius, *V. avida* Osten Sacken, *V. fasciata* Macquart, *V. pusilla* Macquart, *Copestylum marginatum* Say, *Hermetia illucens* Linn., *H. chrysopila* Loew, and *H. hunteri* Coquillett). If the bugs are very numerous and further feeding ensues, the joints gradually change from yellowish to a bluish-black color and they shrink until nothing remains but the completely dried epidermis and fibres.

Recorded observations* show that the joints which have survived limited feeding are not nearly so likely to withstand winter conditions. Frosts which do not affect normal joints often kill the Chelinidea-injured ones. Such indirect damage is stated sometimes to set back the plants by as much as two year's growth.

A number of observations have been made where the feeding of these insects seems to be accompanied by cactus anthracnose, *Gloeosporium lunatum*. This fungus often causes great damage to cactus. While its transmission by the Chelinidea bugs has not been proved, the field observations supported by the feeding habits of the bugs indicate the probability of such carriage of the fungus. A belief that such a condition might exist was expressed to me at the outset of my work by Doctor F. A. Wolf, a former investigator of cactus diseases.

BIBLIOGRAPHY.

References to early papers dealing with species of the genus Chelinidea are to be found in Van Duzee's "Catalogue of Hemiptera of America North of Mexico," 1917. The papers available since the publication of this catalogue are detailed below.

1914. Johnston, T. H. and **Tryon, H.** Queensland: Report of the Prickly-pear Travelling Commission, 1912–1914, 131 pp. 66 figs.
Recommends introduction of Chelinidea spp. to Australia to control prickly-pear.

1917. Froggatt, W. W. Insects and Prickly-pear. Agric. Gaz. N. S. W., 35, No. 6, pp. 417–426, 4 figs.
Mentions a suggestion that *Chelinidea vittigera* be imported from the United States to Australia to control prickly-pear.

1919. Alexander, W. B. The Prickly-pear in Australia. Institute of Science & Industry, Bull. 12.
Suggests importation of *Chelinidea* into Australia for control of prickly-pear.

1919. McAtee, W. L. Notes on Nearctic Heteroptera. Coreidae. Bull. Brooklyn Ent. Soc. 14, pp. 9–13.
Describes new subspecies and varieties of *Chelinidea vittiger* Uhler.

1921. Johnston, T. H. Biological Control of the Prickly-pear Pest. Queensland Agri. Jl., 16, No. 2, pp. 65–68.
Mentions satisfactory breeding of introduced *Chelinidea* bugs.

1922. Johnston, T. H. Report on Investigations regarding Prickly-pear Control by Biological Means. Queensland Agri. Jl., 17, No. 5, pp. 238–240.
Mentions introduction to Australia of four species of *Chelinidea*.

1923. Hamlin, J. C. New Cactus Bugs of the Genus Chelinidea (Hemiptera). Proc. Royal Soc. Queensland, 35, pp. 43–45.
Contains original descriptions of *C. hunteri*, *C. canyona*, and *C. vittigera* var. *texana*.

---

* The Principal Cactus Insects of the United States, by Hunter, Pratt, and Mitchell, (Bull. 113, Bur. Ent., 1912).

NOTES ON SOME TYPES OF AMERICAN MUSCOID DIPTERA IN THE COLLECTION OF THE VIENNA NATURAL HISTORY MUSEUM.

J. M. ALDRICH.

The United States National Museum, through the work of Coquillett, Townsend, and others, has become the repository of a large amount of type material in the muscoid group. Except in Anthomyiidæ, always to be included under the term muscoid (which is merely an equivalent for the older "Muscidæ Calyptratæ"), the National Museum contains most of the type material in existence in America in this group.

There are two European museums which are of especial importance to us for the American muscoid types which they contain: The British Museum, principally for the Van der Wulp Biologia types from Mexico and Central America, and those of Walker's List; and the Vienna Museum, which contains besides some important earlier types principally those of Brauer and Bergenstamm's large publications.

Recently through the kindness of the authorities of the Vienna Museum, and especially of Dr. H. Zerny, custodian, the National Museum has been able to borrow two small but very important lots of American types. It is anticipated that further lots may be obtained, but as the process is rather slow (since we do not wish to risk very many specimens at a time) it is thought best to report now on the first two sendings.

The three papers by Brauer and Bergenstamm, so often cited below, are in Denkschriften Kaiserl. Academie der Wissenschaften, forming parts IV, V and VI of the series begun by Brauer alone, entitled "Die Zweiflügler des Kaiserlichen Museums zu Wien." Part IV is in Band LVI, 1889, pp. 1–180, 11 plates; part V, is in Band LVIII, 1891, pp. 305–446; part VI, is in Band LX, 1893, pp. 89–240. They are referred to below simply with the year and page.

TYPES EXAMINED.

1. *Morellia bipuncta* Wiedemann (*Musca bipuncta* Wiedemann, Auss. Zweifl., II, 1830, 417). Two females, Bahia, "Coll. Winthem." Both labeled type. The National Museum has a good series of both sexes from Higuito, Costa Rica (Schild). Middle tibia without flexor bristle, which gives the species the characters of Morellia in Malloch's recent revision (Ann. & Mag. Nat. Hist., Oct., 1923, 505–528), and runs to the *bipuncta* couplet in his table (p. 524), but is apparently not the species he had. The wing marking was well described by Wiedemann—a square black spot in the costal cell just beyond and including the humeral crossvein, and another spot on the tip of the auxiliary vein. The body color is deep purplish-blue. The parafacial bears a striking spot of yellowish pollen reaching from the eye to the ptilinal suture, and there is a narrow margin of the same pollen beginning on the lower part of the parafrontal next the eye and vanishing upward; elsewhere the parafrontals and parafacials are shining brown, turning to blackish above. The transverse impression is also shining brown, separated from the bucca by a sharp ridge. Disk of thorax without bristles, the hairs arising from fine punctulations; posterior dorsocentrals only one of perceptible size. Calypters dark, the hind one blackish. Male with the same spot on the much narrower parafacial, and also the narrow pollinose eye-border on the lower part of the parafrontal; eyes barely contiguous, the facets of the upper mesial part very large, much larger than the front ocellus.

2. *Sarcophaga plinthopyga* Wiedemann (Auss. Zweif., II, 1830, 360). Male, St. Thomas, with Wiedemann label. Also 17 others, both sexes, one of which is retained. This easily recognizable species was redescribed by me as *Sarcophaga robusta* (Sarcophaga and Allies, 1916, 268, Fig. 128); it is common in Northern Mexico and the southwestern United States, as well as in the West Indies, and has recently been identified from Hawaii. Townsend, Ins. Ins. Menst., VI, 160, 1918, makes *robusta* type of Hystricocnema new genus, on rather slight characters.

3. *Sarcophaga georgina* Wiedemann (Auss. Zweif., II, 1830, 357). Four types. Three are *haemorrhoidalis* Fallen, the other is *falculata* Pandellé, all labeled so by Boettcher, who reported in Deutsche Ent. Ztsch., 1913, 369, that *georgina* is a synonym of *haemorrhoidalis*.

4. *Sarcophaga chrysostoma* Wiedemann (Auss. Zweif., II, 1830, 356). One male marked type, and from the type locality, West Indies. Near my *amoena* (Sarc. and Allies, 1916, 207, Fig. 97), but has median marginals on third abdominal segment, and lacks the conspicuous notch in the tip of the accessory plate. The forceps and penis are shorter. The National Museum has six males from Trinidad Rio, Panama (Busck); Bluefields, Nicaragua (Thornton); Cayenne, Guiana (Schaus); San Rafael, V. C., Mex. (Townsend); and Kingston, Jamaica (Cockerell). Four females from Port of Spain, Trinidad (H. Caracciola), "On dead Mygale," are probably the same.

5. *Sarcophaga rufiventris* Wiedemann (Auss. Zweif., II, 1830, 362). Four specimens, Texas and New Mexico. Three are the same as my identification (Sarc. and Allies, 1916, 150, Fig. 69); they are not types, but help a little to confirm my interpretation, which I took from Coquillett. Townsend, Proc. Biol. Soc., XXX, 45, 1917, makes my species type of *Rafaelia rufiventris* new genus and species, assuming that Wiedemann's is different. The fourth specimen sent has a head glued on that is different and probably came from some other fly; it is therefore useless to attempt to elucidate it.

6. *Erythranda picipes* Brauer and Bergenstamm (1891, 368; 1893, 165). One male, Georgia (Morrison). This is clearly the same as *Brachycoma apicalis* Coquillett, Revis. Tach., 1897, 131, a later name. I compared the types. Townsend (Ins. Ins. Menst., IV, 1916, 19), has proposed the genus Eubrachycoma with *apicalis* as type, also antedated by Erythrandra.

7. *Arrenopus americanus* Brauer and Bergenstamm (1891, 360, 361; 1893, 170). One male, marked type, "Morrison. Georg. Am. 1877, III." Examined by Mr. H. W. Allen, who agreed with me that this is *Senotainia trilineata* Macquart as commonly accepted since Coquillett's Revision, in which work Coquillett placed *americanus* as a synonym, we think correctly. The type of Arrenopus is the European species *piligena* Rondani.

8. *Megaprosopus rufiventris* Macquart (Dipt. Exot., II, pt. 3, 1843, p. 83). One female marked type, Mexico. May have been acquired from Bigot by Bergenstamm. Agrees with Macquart's description, except as to sex. Allied to Microphthalma. A large, robust species, reddish-brown in color throughout except a blackish area on thoracic dorsum, not reaching the scutellum. Legs reddish-brown, head same above but a little paler below. Profile of head as in *Microphthalma disjuncta*, parafacials nearly bare. Sternopleurals 3 one side, 4 the other. Abdomen without discals, first segment without marginals, second with three pairs, third with a continuous row above and below, fourth with the usual row a trifle beyond middle smaller than preceding, and small apicals. All tergites with ventral spines, and the sternites seem to have a few. Wing with long appendage on bend of fourth vein as in Microphthalma.

This is the type species of Megaprosopus Macquart (BB, 1889, 117; 1893, 171), which differs from Microphthalma principally in having stout ventral abdominal bristles or spines, located mostly on the inflexed ends of the tergites.

The only representatives of the genus in the National Museum Collection are several types of Townsend's *Megaprosopus rufiventris andinus*, Proc. U. S. N. M., 43, 1912, 365; although described as a subspecies it is clearly distinct but undoubtedly congeneric.

9. *Macrometopa mexicana* Brauer and Bergenstamm (1889, 117; 1891, 362; 1893, 172). Four males, one retained by the National Museum by permission. Not previously represented in the Museum. A prior name is *calogaster* Bigot, Annales, 1888, 266, described as

Microphthalma; Van der Wulp figures the species (Biologia, Dipt., II, 245, Pl. 5, Fig. 14) and asserts the synonomy, later confirmed by Brauer. Type of Macrometopa. Allied to Microphthalma, but differs in having the bend of the fourth vein swung back and rounded, while in Microphthalma it is straight and bears a long fork; the head is more produced forward below, so that the profile is nearly square. The venter is destitute of spines. The sides of the abdomen are red, the black forming a broad stripe down the middle, on each side of which in well preserved specimens the pollen is dense and white. Segments 2 and 3 with several pairs of discals.

10. *Prorhynchops bilimeki* Brauer and Bergenstamm (1891, 364; 1893, 174). One female, type, labeled "Mexico. Mazatl. 1883 T." In the collection of W. R. Walton, donated to the National Museum a few years ago, there are a female and two males which are undoubtedly this species; they are from Real del Monte, Hidalgo, Mexico. As this species is the type of Prorhynchops, in the midst of the greatly confused mass of Dexiid genera, it is necessary to consider the characters carefully.

Female (type). The head is very strongly developed below. The proportions are as follows in micrometer units: Entire width of head from in front, 58; width of vertex, 17 (.3 of headwidth); height of head in profile, 52 (eye, 31, bucca, 21); length of head (side view) at antennæ, 39, at vibrissæ, 41; length of third antennal joint, 9; of terminal joint of proboscis from elbow to base of labella, 39; of palpus, 19.

Frontal bristles ordinary, stopping at insertion of antennæ; two pairs of verticals, one of ocellars, two of orbitals as usual; parafacial with small hairs, which extend down on parafacial to the transverse impression which is very broad, red, bare; vibrissæ only slightly above the protuberant epistoma, not unusually approximated; facé with moderate keel above. Palpi yellow, antennæ red to arista, the last with moderate plumosity. Thoracic chaetotaxy: dorsocentral 2, 4; acrostichal 2, 2; humeral 5 or 6; posthumeral 2; presutural 1; notopleural 2; supraalar 3; intraalar 3; postalar 2; scutellar 2 lateral (a small between), 1 apical rather long, depressed, 1 discal; sternopleural 2 and 1. Postscutellum prominent. Hind calypter distinctly infuscated, its rim and fringe pale. Abdomen reddish with a median black stripe; the first segment has no median bristles; the second a marginal pair and a small discal pair; the third a stout discal pair and a marginal row; the fourth with discal and smaller marginal row. Legs black, the tibiæ yellowish. Wings strongly infuscated as far as the basal crossveins and on the small crossvein; fourth vein strongly curved backward beyond the hind crossvein, then with a short curve forward, ending well before tip of wing, apical cell open. Third vein with 3–4 hairs at base above which are rubbed off, several below are very distinct.

Male. Front before ocelli .07 and .08 of the headwidth in the two specimens. Verticals slender and hairlike, ocellars hardly distinguishable from hairs; frontals beginning below the narrowest part of the front; hairs of parafacials longer than in female and encroaching a little on the facial impression. The median black stripe of the abdomen is wedge-

shaped, broad anteriorly; discal bristles on both second and third segments, one or two pairs irregularly placed.

Length of female, 10 mm.; of male, 12 mm.

11. ***Eudexia goliath*** Brauer and Bergenstamm (1889, 120; 1893, 174, 182). One male, "Lindig, 1864, Venezuela." Labeled type. According to Brauer (Sitzungsber. Kais. Akad., CVI, 31, 1897), Bigot had described this species earlier under the name ***Rhamphinina formidabilis*** (Annales Soc. Ent. France, 1888, 264); Brauer examined Bigot's type. We have one male in the National Museum, collected by Pablo Schild at Higuito, Costa Rica; a second like it was sent to Professor Bezzi and he determined it correctly. Bigot's description contained some typographical errors, making it confused in the abdominal color. A very large species with abdomen somewhat inflated and of translucent light yellow color, with or without an interrupted median black stripe, the apical segments black. Van der Wulp (Biologia, Dipt., II, 1891, 220) gives a good description and figure. This is the type of Eudexia; the type of Rhamphinina is ***dubia*** Bigot, both genus and species being described in Bull. Soc. Ent. France, 14 Jan., 1885, p. XI. There were four types of ***dubia***, of which Brauer reported on two in Sitzungsber, CVIII, 509, 1899. One of the specimens he puts in Ptilodexia, the other in Macrometopa, but with no description of the characters. At present nothing can be made of Rhamphinina.

12. ***Echinodexia pseudohystricia*** Brauer and Bergenstamm (1893, 174, 182; Hystrisiphona non Bigot, 1889, 120). One female, "Mexico, 1871, Takubaya." Marked type. The National Museum has a male from Federal District, Mexico, of the same species. Head and thorax to the scutellum densely covered, as viewed from above, with yellow pollen; scutellum and abdomen contrasting deep black, the abdomen shining; wings infuscated, the base yellow. In all the color pattern is very striking. The extremely dense mass of erect black spines beginning in the middle at the front edge of the second segment of the abdomen and spreading over the whole dorsal surface farther back, is the chief character. The head characters are precisely those of Eudexia. Type of the genus.

13. ***Myiophasia aenea*** Wiedemann (Anss. Zweifl., II, 298, 1830; BB., 1891, 362; 1893, 170). One male, with Wiedemann's label as ***Tachina aenea***. It bears a pen and ink locality label "Montevideo." The specimen is now in poor condition, having lost the abdomen, one wing, and all the legs but the femur and tibia of one front one. The head and one wing are, however, still in excellent condition. The head agrees perfectly with that of specimens of ***Phasioclista metallica*** Townsend from Georgia (Morrison), mentioned as ***aenea*** by Brauer and Bergenstamm in 1893 and sent to us for comparison by Zerny. The wing also agrees, except that the hind crossvein is a trifle nearer the bend of fourth vein than in the Georgia specimens, but not nearer than in some specimens in the National Museum. The conclusion is irresistible that Brauer and Bergenstamm were correct in identifying the Georgia specimens with ***aenea***, and that ***metallica*** is the same. Townsend has

pointed out that there was a *Tachina aenea* earlier than 1830, hence it is preoccupied (Ins. Ins. Menst., IV, 1916, 11). He proposes *australis*, new name, as a substitute, but it is apparent that this is unnecessary, as *metallica* will serve. Whether *Clytia atra* Robineau-Desvoidy (Myodaires, 1830, 228, from Carolina) is available I leave open.

The great differences in the faunal region of Montevideo from that of North America suggests that the locality label of Wiedemann's type is erroneous; the specimen may have been from North America.

As a side light on Brauer and Bergenstamm's work I may mention that I received besides the type 10 specimens each separately labeled *Myiophasia aenea* by Brauer and Bergenstamm; Six of these are *metallica*, 3 are *globosa* Townsend, and 1 is *nigrifrons* Townsend. From which it would appear that they lumped the forms about as Coquillett did.

14. *Angiorhina crudelis* Wiedemann (*Tachina crudelis* Wiedemann, Auss. Zweifl., II, 1830, 300; Brauer and Bergenstamm, 1889, 163; 1891, 362; 1893, 171). One female labeled "Ind. orient.," then the latter word crossed off and "occ." written over, apparently in Brauer's writing. The specimen agrees exactly with Wiedemann's description and is marked type. Type of the genus Angiorhina. It agrees with Myiophasia at least in the wide sense. In Townsend's table of Myiophasia it does not agree with any of the forms, but his later *Euloewiopsis setosa* from Brazil (Bull. Amer. Mus. N. H., XXXVII, 1917, p. 222) appears from the description to be nearly if not quite the same; unfortunately this is not in the National Museum, being the only one lacking of the forms recognized by Townsend. *Crudelis* type has the apical cell ending distinctly before the extreme apex, closed in the margin; hind crossvein not parallel in direction with the fourth vein beyond the bend; eyes distinctly hairy; second abdominal without median marginals. Vibrissæ higher up than in *metallica*, almost exactly halfway between insertion of antennae and epistoma; bucca also high, three-fourths of the eye-height, and transverse impression very broad; antennæ and palpi bright orange yellow. Parafacials, parafrontals and back part of head all with smooth white pollen; parafacials at lowest anterior edge with about 4 quite good-sized bristles, behind these the hairs are microscopic and mostly in one row; frontals 5 or 6; the usual 2 proclinate orbitals; ocellars large, proclinate; verticals 2 pairs. Front legs quite black, other legs absent. Abdomen black, with dense whitish pollen at base of each segment, which is tessellated and in different views more or less extended toward apex of segments, generally more than half of each segment is black, subshining. This is the only species in the group unless it be *setosa* that has tessellated pollen. Length, 6.4 mm.

15. *Oestrophasia clausa* Brauer and Bergenstamm (1889, 145; 1893, 158). One male, "S. Colorado," "Alte Sammlung." One female, Golden, Colo. Both marked type. They run without difficulty to *clausa* in Coquillett's Revision. Coquillett's later *Oestrophasia setosa* (Proc. U. S. N. M., XXV, 1902, 110) is the same, as already announced by Townsend (Ent. News, XXVI, 1915, 366). Judging by

manuscript notes in his personal copy of his Revision, Coquillett thought there was a specific difference in the rows of frontal bristles, which are somewhat variable.

16. ***Phiasopteryx bilimeki*** Brauer and Bergenstamm (1889, 146; 1891, 388; 1893, 159). One male, one female, both marked type; the former is "Mexico," "Alte Sammlung," the latter "Bilimek, Mexico, 1871, Orizaba." The two sexes agree absolutely with specimens determined as ***Ormia punctata*** Robineau-Desvoidy by Townsend; there is no reason to doubt the synonomy. The swollen head in Oestrophasia seems a sufficient generic character to separate it from this.

17. ***Tetragrapha tessellata*** Brauer and Bergenstamm (1891, 351; 1893, 124). One male type, "Cuba." Redescribed by Aldrich and Webber, Proc. U. S. N. M., vol. 63, art. 17, p. 47, in the genus Phorocera, subgenus Parasetigena. It is much like ***Phorocera claripennis*** Macquart, and cannot possibly be separated generically from that species. Type of the genus Tetragrapha, which thus becomes a synonym.

18. ***Podotachina vibrissata*** Brauer and Bergenstamm (1891, 350; 1893, 124). One male type "N. York." I spread the genitalia, and it is undoubtedly ***Phorocera claripennis*** Macquart, as Coquillett identified the latter and as I accept it. The abdomen is more reddish on the sides than usual. Coquillett (Revision, 1897, 102) correctly placed ***vibrissata***.

19. ***Podotachina americana*** Brauer and Bergenstamm (1891, 350). One male type, labeled as preceding. I spread the genitalia. It has much similarity to our Parasetigena group (Euphorocera Tns.), but the facial ridges have only small hairs about two-fifths of the way, instead of the stout, erect bristles that run much higher in the forms allied to ***claripennis***. I could not find any American species agreeing with ***americana*** Brauer and Bergenstamm, but by great good fortune I found it from India. It was described by Becher as ***Tricholyga bombycis*** (Ind. Mus. Notes, I, 77, pl. V, F. 1) and Coquillett had identified a pair from Calcutta some years ago, of which I had spread the male genitalia. There is no doubt whatever about the identification, as the genitalia are unique. The locality label must be erroneous. The inner forceps are united into a plate which is deeply grooved behind the anus; along each side of this groove is a dense series of stiff yellow hairs which point toward the middle line and apex, the tips overlapping along the middle line. The apex of the plate is flattened and tapers abruptly, ending in a slight hook.

Podotachina had three originally included species, the other being ***sorbillans*** Wiedemann, from the Canary Islands, which Townsend designated as type (Ins. Ins. Menst., V, 1916). The validity of the genus remains to be settled by the examination of this species, which, however, will not affect us.

20. ***Parahypochaeta heteroneura*** Brauer and Bergenstamm (1891, 337; 1893, 117). One female, type. Genotype of Parahypochaeta. The locality is simply "N. Am." At first I thought it identical with ***Chaetophlepsis tarsalis*** Townsend (***Hypochaeta longicornis*** of Coquillett),

but the front at antenna is less prominent, head from in front less widened, discals absent from second abdominal, and especially the hind crossvein is not drawn in, the last segment of the fifth vein measuring .3 of the preceding, while in *tarsalis* it is more than .5. Other characters are the same in both—ocellars erect and turned back; sternopleurals two, long and divergent, arising close together; first vein hairy all its length, third with only 2–3 at base, the last strikingly large; one very large hair or small bristle on upper side of costa near sub-epaulet, nearly as long as costal segment beyond humeral crossvein.

21. *Plagiomima disparata* Brauer and Bergenstamm (1891, 384; 1893, 140). One male, one female. Both "Bilimek, Mexico," the male dated 1883, the other 1871. The former may be considered the real type, but they are the same species. Siphoplagia Townsend is a synonym, Plagiomima having the same slight priority as Myiophasia over Phasioclista and Ennyomma. Whether *anomala* Townsend, type of Siphoplagia, is identical with *disparata*, type of Plagiomima, is doubtful; the latter has the fifth vein bristly, in both types, which occurs only rarely in *anomala;* the form of *anomala* is more robust, and its size larger, which runs very uniformly through our large series, hence I regard *disparata* as a valid species for the present.

22. *Myiopharus metopia* Brauer and Bergenstamm (1889, 161; 1891, 340, 358; 1893, 120). Two males, both marked type; one is labeled "Bilimek. Mexico, 1871. Takubaya," the other simply "Mexico." Brauer and Bergenstamm were deceived by the orbital bristles and called these both females. Type of the genus. We have three males agreeing with *metopia;* one from Mexico City (R. Muller), one from Volcan Santa Maria, Guatemala (Schaus and Barnes), and one from Higuito, Costa Rica (Schild). Townsend's Hemiargyra (Muscoid Flies, 1908, 88, type *nigra*, new) is a synonym. In 1916, contrary to his usual custom, Townsend placed a second species in this genus, *huascaraya* (Ins. Ins. Menst., IV, 125), from Peru. Brauer and Bergenstamm also place *Didyma moesta* Van der Wulp, (Biologia, Dipt., II, 1890, 158) as a synonym of *metopia* (1891, 358) but without having seen the type.

Huascaraya has a mostly shining abdomen and is easily distinct. *Moesta* is too poorly described to place satisfactorily. We have then to compare *nigra* Townsend, genotype of Hemiargyra, with *metopia*. Both species have densely hairy eyes, orbitals in males (females unknown); brilliant silvery pollen on the broad parafacials and parafrontals from the lowest orbital, above this velvety black; entire thorax and first abdominal segment velvety black; second and third abdominals with discal and marginal bristles and pale pollen covering dorsal surface, the pollen in *nigra* whiter and possibly approaching silvery in life.

The *nigra* type (from Costa Rica) is larger, the front less prominent, facial ridges more strongly bristled by a little, and the tip of the scutellum bears a sub-silvery spot of pollen; these are all slight differences, but seem to be specific. The relationships are with Doryphorophaga and not at all with Metopia.

23. *Hesperomyia erythrocera* Brauer and Bergenstamm (1889, 114; 1891, 359; 1893, 162). One male, Texas. Brauer and Bergenstamm placed this near Miltogramma and later in their Sarcophaga group; Townsend (Proc. U. S. N. M., 56, 566, 1919), has described the same genus under the name Oestroplagia and in his latest unpublished arrangement puts it in Voriini. Townsend's sole species is *petiolata*, represented by a single male type from Santa Catalina Mts., Arizona. This is so nearly the same as *erythrocera* that I spent much time analyzing the differences, without feeling quite certain that the two are not identical. Fortunately, Mr. H. J. Reinhard had two Texas males of undoubted *erythrocera*, which he kindly added to our collection, one of which I have labeled "compared with type." *Petiolata* has a somewhat narrower front, and a few more frontal bristles in both rows, which sounds more convincing than it looks, for the resemblance is very great. There can be no doubt that Oestroplagia is a synonym; more material may perhaps make *petiolata* out a distinct species. Hesperomyia may be recognized by having the apical cell long petiolate, bend of fourth vein with long stump; last segment of fifth a little more than half as long as the preceding; second antennal joint almost as long as third; frontal bristles in two rows; arista bare; a large pteropleural bristle. Contrary to the statement of Brauer and Bergenstamm, the parafacials are bare. It has, I think, no nearer relation to Miltogramma or Sarcophaga.

24. *Hemithrixon oestriforme* Brauer and Bergenstamm (1891, 357; 1893, 157). One male type, "S. Colorado." The same as the later *Coquillettina plankii* Walton (Proc. Ent. Soc. Wash., XVIII, 1915, 104), as already indicated by Townsend (Ins. Ins. Menst., IV, 1916, 126).

25. *Pseudogermaria georgiæ* Brauer and Bergenstamm (1891, 352; 1893, 125). One female type, "Georg. Am." (Morrison). The ocellars are stout and reclinate; there is an intermediate row of frontals of four on each side, between the orbitals and the regular frontal row, the latter of 9 on one side and 10 on the other, reaching down to the tip of the second joint; facial ridges with four erect bristles on one side, 5 on the other, ascending above middle of third antennal joint; parafacials with a few delicate hairs along the lower curve of the eye in a roundish group, bare above to the frontals; antennæ red to base of third joint, the second barely half the third, arista short with long basal joint which on one side is half as long as the apical, on the other less. Parafrontals yellowish above, becoming white below, the parafacials rather silvery, not at all yellow. Viewed directly from in front, the vertex is nearly as wide as the distance between the eyes across the vibrissæ (in the proportion of 19 to 26, the entire head-width being 54 by micrometer). Palpi yellow, normal; proboscis short; bucca about one-fifth the eye-height. Eyes hairy. Scutellum with 3 lateral pairs and an apical about half as long, depressed and slightly divaricate; posterior dorsocentrals 4; sternopleural 4; pteropleural as large as the largest sternopleural. Abdomen without median marginals on first segment, with a stout erect pair on second, a row on third and fourth, the fourth red in ground color. Middle tibia with three large bristles on outer front side, hind

tibia with numerous but unequal bristles on outer side, among which two near middle are larger. Apical cell of wing open far before apex, bend of fourth vein rectangular but a little rounded, third vein with 3–5 hairs at base. Length, 8 mm.

The characters in this immediate group are so variable that I have taken pains to be exact in those cited, in case anything specific should be developed later. The type female of Townsend's *Paragermaria autumnalis* (Ann. Ent. Soc. Amer., II, 1909, 247), the type species of its genus, differs very little; it has the pollen of the head decidedly yellow, and a few more hairs ascending along the parafacial. The latter character, however, varies in our series of the species; we have, however, no specimens with silvery pollen. There seems to be no other distinguishing mark, and considering the obvious variability in other respects, I would not consider this specific. Hence I would make *Paragermaria autumnalis* a synonym.

26. *Eliozeta americana* Brauer and Bergenstamm (1891, 407). Five types all so labeled, both sexes, all "Morrison. Georg. Am., 1877, III." They are *Cistogaster occidua* Walker, as this species is identified by Townsend (Trans. Amer. Ent. Soc., XXII, 1895, 66; and Ann. & Mag. Nat. Hist., XIX, 1897, 31; XX, 283, 1897; and Muscoid Flies, 1908, 127). He finally placed both *occidua* and *immaculata* in Gymnoclytia, but I regard this as a synonym of Cistogaster. The genus Eliozeta is by Rondani (Prodrome, 1856, I, 82), with type *Tachina pellucens* Meigen. This species is in the National Museum, thanks to Professor Bezzi, and is not congeneric with Cistogaster, having bristles on the abdomen. It is not North American.

AN AMERICAN TETTIGOMETRID (HOMOPTERA).

FREDERICK MUIR,
Honolulu, T. H.

Genus **Nototettigometra** nov.

Length of vertex in middle two-thirds the width between eyes, anterior margin arcuate, on middle line projecting in front of eyes about half its length; base ill defined from occiput which does not project beyond the lateral margins of eyes but barely reaches it, disc slightly concave; head, including eyes, five sixths the width of pronotum; antennæ reaching some distance laterad of eyes; frons in profile slightly concave from base to antennæ, where there is a slight ridge, and then slightly convex. Eyes fairly small; ocelli distinct, on frons near inner basal corner of eyes, the lateral carinæ of frons slightly in front of antennæ but do not reach ocelli. First segment of antennæ broader than long, segment from four to five times the length of first. Pronotum considerably shorter than vertex, hind margin very slightly arcuately emarginate or subtruncate. Mesonotum a little longer than vertex and pronotum together, wider than long. Legs short, stout, first and second femora slightly flattened, hind legs reaching slightly beyond apex of tegmen. When at rest tegmina narrowing slightly to apex, the individual tegmen being subparallel sided, apex round, costal margin slightly arcuate. Clavus reaching one-fourth from apex, claval fork one-third from apex of clavus; costa coincident with costal margin; Sc and R arising from basal cell, simple, reaching to apex, M arising from basal cell with a simple fork in middle, Cu simple, without fork, a number of obscure, irregular pseudocross-veins in apical half; wings ample, folding and overlapping when in repose. The basal third of the costal margin turned under forming an epipleura which fits against the thorax.

This genus stands between *Tettigometra* Latrielle and *Brachycephalus* Signoret (=*Brachyceps* Kirkaldy, n. n.) having certain characters of both. The male genitalia are unique and will be discussed below. The venation is more generalized than in any other species of the family that the writer is acquainted with, Sc and R being separate from base.

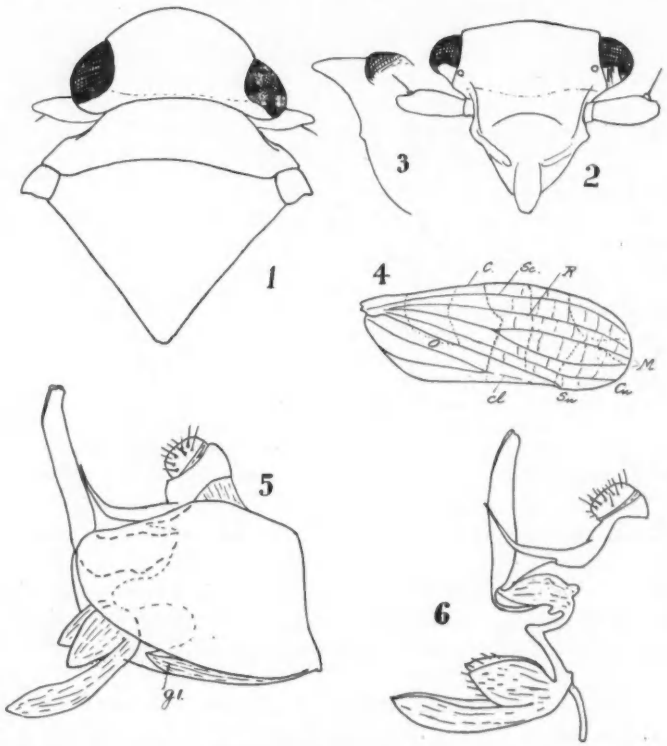
Nototettigometra breddini sp. n.

Male.—Length 3.6 mm:; tegmen 3 mm.

Light brown; a dark brown or nearly black band across the frons between the eyes, basad of this band lighter brown, distad of the band frons and clypeus yellow, vertex and pronotum slightly speckled with brown dots; the basal angle of mesonotum yellow with two opaque,

creamy spots at the sides, a slightly larger opaque spot on margin half way between lateral angles and base, the margin of the posterior half slightly darker brown; legs light brown or yellow speckled with brown spots.

Tegmina light brown with an ill defined lighter band across middle, a lighter mark from basal half of costa to claval suture, near this mark, between the suture and the first claval vein, there is a small, oblong, opaquely white spot surrounded by a dark area; at the apex there are two lighter spots which more or less run together making the apex lighter, especially at the sides; a number of small reddish brown spots



1. *Nototettigometra breddini*, dorsal view of head, pronotum and mesonotum.
2. *Nototettigometra breddini*, front view of head.
3. *Nototettigometra breddini*, profile of frons and vertex before eyes.
4. *Nototettigometra breddini*, right tegmen.
5. *Nototettigometra breddini*, right side view, male genitalia.
6. *Nototettigometra breddini*, right side view of anal segment, aedeagus and appendage.

scattered over the whole tegmen, more thickly along the commissure of clavus, also more or less over the thorax and head. The tegmina, thorax and head also bear many microtrichia irregularly disposed, those on the tegmina do not follow the veins. Venation very faint except in prepared specimens.

Pygofer slightly compressed laterally, the opening being narrow, much longer than broad, the medio-ventral surface of pygofer semi-membranous, in lateral view the lateral margins roundly produced. Anal segment small, distinctly divided into two segments (10 and 11?) the basal bearing a long, slender, acute process, bent at the middle. The ædeagus is long, tubular, slender, bent at nearly a right angle one-third from base, the basal part being membranous and may represent the periandrium; functional orifice at apex and continued along ventral aspect as a narrow opening. The genital styles are absent or only represented by two small, flat, membranous appendages. Below the ædeagus, and connected therewith by the apodeme, is a boat shaped, membranous organ with the basal edges produced into wing-like processes, which are also membranous. Whether these latter are modified genital styles or not it is difficult to say.

Female.—Similar in size, build and color to the male. The ovipositor is rudimentary or entirely missing.

Described from three males and three females. The male holotype and female allotype are typically colored, but three of the others are very much lighter and one female is light green, but with faint indications of the design.

These specimens were received from Dr. W. Horn, Berlin, and were mounted on one card with a label "Peru," and another, printed, label, "coll. Breddin." In the same collection of Homoptera there are several typical South American insects, (i. e., *Cladoptera* and *Cladypha*), bearing a locality label "Peru" written in the same handwriting. If Dr. Breddin collected these himself, or if they only came from his collection, I am unable to say. But there is every reason to consider the locality authentic.

So far as the writer knows this is the first species of this interesting little family to be reported from either North or South America, and is, therefore, of considerable interest. The family has not yet been reported from Australia, but it is known from all the other zoological areas. Although the family is small, it is of great taxonomic interest. The writer has placed it in an isolated position among the Fulgoroidea.* This agrees with Van Duzee's opinion that it is more distinct from

* Pro. Hawaiian Ent. Soc. V, (2), p. 220, 245, (1923).

the rest of the families of Fulgorids than they are from one another. The writer would rather erect a super-family for this family than consider the other fulgorid families as only sub-families. The examination of a nymph of *Megaloplastinæ* from Java shows that there is no intestinal "filter" or "columa" therein agreeing with the other fulgorids and with the Cicadellidæ.

Elsewhere* the writer has figured the male genitalia of *Egropa breviceps* (Stal) and a species of *Tettigometra*, and he has also examined *Megaloplastinæ*, and there are two distinct types. One type is represented by *Tettigometra*, in which the periandrium is large and ring-shape and the penis passes through it; the other type has the periandrium small and the penis does not pass through it, but is distad. In *Egropa* and *Megaloplastinæ* there is a large membrane below the genital stylus which appears to be homologous with the boat-shaped membrane in *Nototettigometra*. The membrane in the middle of the ventral aspect of the pygofer (Fig. 5, g1) the writer considers represent the anterior gonopophyses which in Tettigometra are large, flat and projecting.

It is of great interest to note that among the few species of this small family of which the male genitalia have been examined we find traces of all the types found in the Cicadoidea and Fulgoroidea. The absence of free genital styles, as in all Cicadidae except one genus, the Munopline type of Aedeagus, the Ciscune type of Aedeagus, the anterior gonopophyses well developed and distinct, or incorporated into the pygofer. These, together with other synthetic characters, all show the important part this family plays in the phylogeny of the fulgorids.

---

* Pro. Hawaiian Ent. Soc. V, (2), Plate IV, Figs. 1, 2, (1923).

STRIDULATION OF BUENOA LIMNOCASTORIS HUNGERFORD AND SYSTEMATIC NOTES ON THE BUENOA OF THE DOUGLAS LAKE REGION OF MICHIGAN, WITH THE DESCRIPTION OF A NEW FORM. (NOTONECTIDAE-HEMIPTERA)*

H. B. Hungerford,
Professor of Entomology, University of Kansas,
Lawrence, Kansas.

Several years ago the writer discovered stridular areas on the anterior femora and tibiæ of the males of *Buenoa margaritacea* Bueno. These he figured in an account of the life history of this backswimmer which appeared in the Entomological News, Vol. XXVIII, pp. 174–183, 1917. Of course it was surmised that these structures were concerned with sound production although the insects had not been heard to stridulate. On various occasions since that time *B. margaritacea* Bueno males have been confined in aquaria in the laboratory with the hope that a chance observation might be made regarding their chirping but without results. Since no real effort had been made to secure information on this point, it was determined to study the behavior of the species in the vicinity of the University of Michigan Biological Field Station on Douglas Lake.

With this end in view *Buenoa limnocastoris* was captured in numbers and the sexes placed in separate aquaria and kept under observation. Two entire days were devoted to this sort of study without gaining any information. A third attempt was made, this time bringing the insects to the laboratory in a fish pail containing water from the pool in which they lived. They began to chirp almost as soon as the pail was brought to the laboratory, and it was apparent, even in the obscure light of the pail that the females inspired the singing. Three pairs were then placed in a large stew pan containing about two inches of water and their behavior studied with the free body of a Bausch and Lomb Binocular, using 10X eye pieces and 55

* Contribution from the University of Michigan Biological Field Station on Douglas Lake.

mm. objectives. Some observations were made using 32 mm. objectives, and several very favorable close-up studies recorded. Like the others of this family, the Buenoa swim on their backs. They poise and swim submerged, keeping an even keel and maintaining their position at any level in the water in a remarkably graceful manner. Thus it is possible to study the movements of the legs and beak of the insect as it rests or slowly glides through the water.

The males are smaller and sufficiently different in shape from the females to be readily distinguished. During the mating season it should be easy for any one to hear these interesting aquatic songsters. They sing their courting songs at all hours of the day or night—on cloudy days or clear days, in sunshine or shadow. In the aquarium containing the three pairs, there were times when all three males were chirping at once. But to appreciate the full significance of these amorous serenades, it is necessary to watch the behavior of the insects. The male singles out a female, maneuvers for a position some little distance beneath and behind her and begins a ticking sound as he slowly cruises nearer the object of his desire, his body aquiver with emotion. When within a half inch or so of the female, the ticking changes to a hum and is followed by a sudden dash to embrace her. If she eludes him, he begins all over again or transfers his affection to another. Sometimes when a female, aware of the attentions bestowed upon her, moves away from the chirping male, the latter will turn to follow another female that may pass nearby, and resume his mating call. In a few cases one male has been observed to follow and chirp to another male.

The sound produced by these insects is a ringing chick-chick-chick-chick like the ticking of a watch that can be heard fifteen or twenty feet away. This may continue for a minute or two, and then if the male has succeeded in drawing near the female, the note changes to a rapid twir-r-r made by a very rapid continuous series of chicks. The sound is made by the shuffling back and forth of the front femora and tibiæ along the beak, both legs in unison. The roughened structures near the inner base of the tibiæ and on the inner faces of the femora rub against a scraper-like device on the base of the beak. A comparison of the fore limbs and beaks of the two sexes will show the modifications developed in the male for stridulation.

In mating the male is below the female, the genital segments reach around the right side of the female and the front and middle legs are employed in the mating clasp.

The above notes concern *Buenoa limnocastoris* which was described recently in Entomological News, Vol. XXXIV, p. 149, from material taken in Minnesota. This species is the common one in Sedge Point Pool on the north shore of Douglas Lake. In 1919 R. F. Hussey published a report on the water bugs of the Douglas Lake region. This appeared as Number 75 of the "Occasional Papers of the Museum of Zoology," University of Michigan and represented the results of work started by Miss Eva G. Miller in 1913, continued by her during the season of 1914 and completed by Mr. Hussey in 1918. In the report of the collections of the three seasons of work, Mr. R. F. Hussey records two Buenoa species. One he calls *Buenoa platycnemis* (Fieb) and the other, *Buenoa elegans* (Fieber). An examination of collections made by the writer during the summer of 1923 shows the presence of three species. At Sedge Point Pool the recently described *Buenoa limnocastoris* is quite common while in the little pond at Bryant's Bog on the southwest side of Douglas Lake, *Buenoa elegans* (Fieber), which is a small species and an unnamed large species with broad front tibiæ, are to be taken. The smaller species is much commoner than the larger. It may be this larger species that has been called *B. platycnemis*. It is probable, however, that Fieber's *B. platycnemis* is quite a different insect.

This new species is related to the *Buenoa elegans* (Fieb.) and *Buenoa limnocastoris* Hungerford, branch of the genus rather than to the *B. margaritacea* Bueno. forms. More than fifty specimens were taken from Bryant's Bog, a small number of which were preserved in alcohol and dissected for the study of structure.

A recent examination of some specimens taken by me in Minnesota prove them to be this species. The following description is drawn therefore from a group of fifty specimens from Michigan and Minnesota.

Buenoa macrotibialis nsp.

Size: Length 6.25 to 7.5 mm., width across the eyes in largest female 1.4 mm., greatest body width 1.9 mm.

Color: White, sometimes with small dark spots on sides of thorax and abdomen as in ***Buenoa elegans*** Fieb and ***B. limnocastoris*** Hungerford, but not extensively marked with black as in the other species.

Shape: Females with bodies quite arched above; eyes, as seen in lateral view more sharply convex in front and flatter above than any other species known from North America. The very broad flat tibia of the male is a striking character that distinguishes the insect at once, and suggests the specific name proposed.

Structural peculiarities: The tylus of the male is not as prominent as in ***Buenoa limnocastoris*** Hungerford and the eyes are quite different in shape as shown by the accompanying plate (Figs. 1 and 6, Plate XXII). The pronotum of both sexes is provided with a distinct median longitudinal carina, more marked than in either of the other species mentioned above. Its anterior margin is projected conspicuously and acutely between the eyes in both sexes. The pronotum of the male is not inflated but rather, laterally depressed on the caudo-lateral portions. Scutellum reduced but not as much as in ***Buenoa limnocastoris;*** in the female, scutellum a trifle less than the length of the pronotum; in the male, scutellum is over one-half length of pronotum; the claval orifice is relatively small, less than one-half the length of the scutellum in both sexes. The elytral suture is longer than in ***B. limnocastoris*** Hungerford. Front femora of the male, greatly enlarged and the tibiæ very broad (see figures on Plate XXII.)

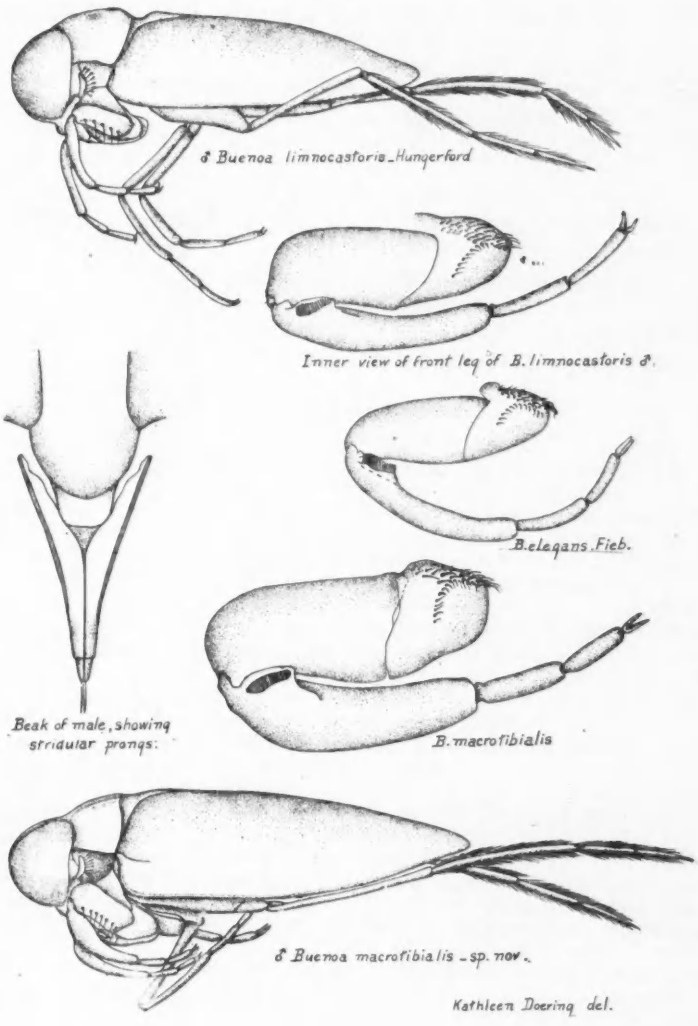
Holotype: Male, Douglas Lake, Mich., Bryant's Bog, Aug. 3, 1923.

Allotype: Female, Douglas Lake, Mich., Bryant's Bog, Aug. 1, 1923.

Paratypes: 9 specimens, Douglas Lake, Mich., Bryant's Bog, Aug. 3, 1923; 4 specimens, Douglas Lake, Mich., Bryant's Bog, July 17, 1923; 21 specimens, Douglas Lake, Mich., Bryant's Bog, July 29, 1923; 13 specimens, Pelican Rapids, Minn., Aug. 22, 1922.

All the above taken by H. B. Hungerford.

Holotype and allotype and some paratypes in University of Kansas collection; paratypes in Museum of Zoology, University of Michigan, Minnesota University collection, United States Natural Museum, and the following private collections: J. R. de la Torre Bueno, R. F. Hussey, H. M. Parshlry, Carl J. Drake, W. H. Hoffman and that of the writer.


♂ Buenoa limnocastoris-Hungerford
Inner view of front leg of B. limnocastoris ♂.
B. elegans. Fieb.
Beak of male, showing stridular prongs.
B. macrofibialis
♂ Buenoa macrofibialis - sp. nov.
Kathleen Doering del.

H. B. Hungerford

ON A NEW GENUS AND SPECIES OF THE GERRIDÆ FROM FORMOSA.

By Teiso Esaki,
Entomological Laboratory, College of Agriculture,
Kiushiu Imperial University, Fukuoka, Japan.

In a small collection of aquatic Heteroptera, kindly presented to me by Mr. Ryoichi Takahashi, of the Department of Agriculture, Government Research Institute of Formosa, a very beautiful species of the family Gerridæ was found which is undoubtedly a new species belonging to a new genus. I must express my hearty thanks to the donor of the specimen, to whom I am much indebted for many favors.

Strongylovelia gen. nov.

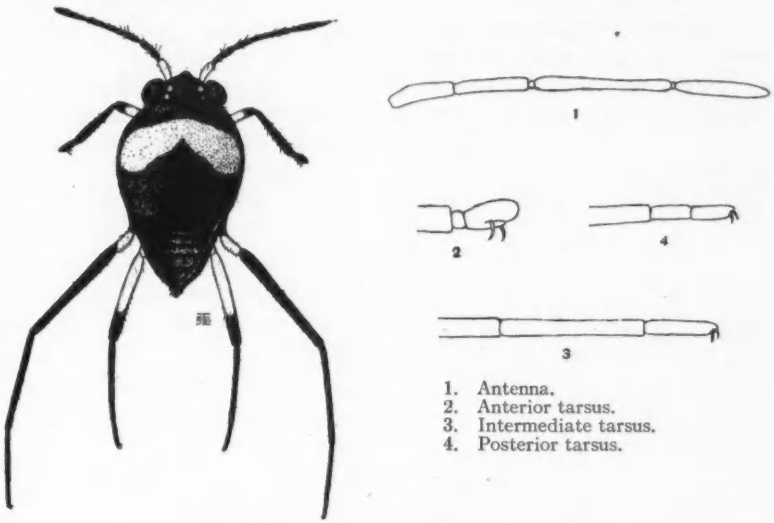
Body much rounded, globular. Head transverse, coarsely punctured and much setose. Eyes prominent, much produced laterally, free from the anterior margin of the pronotum. Antennæ long; first joint slightly thickened and somewhat curved, second slightly longer than first, third longest and slender, about twice the length of first, fourth a little longer than first, moderately thickened towards the apex. Rostrum long, reaching the anterior coxæ, second joint shortest, third longest, fourth a little longer than half the length of third. Pronotum narrow, meso- and metanotum together very much rounded and convex, almost hemispherical. Anterior legs short, coxa short, trochanter about twice the length of the coxa, femur and tibia subequal in length, the former being thicker than the latter, tarsus short, first joint very short, somewhat globular in shape, second about three times as long as the first, claws situated near the center of second joint. Intermediate legs very long, coxa short, trochanter about twice as long as coxa, femur thickened, long, tibia a little shorter and much thinner than femur, first joint of tarsus about twice the length of second. Posterior legs much shorter than intermediate ones, coxa and trochanter short, femur much produced beyond the end of abdomen, thickened, tibia much thinner than femur and subequal to the last length, tarsus short, first and second joints nearly equal in length. Abdomen short, considerably narrowed towards the apex, lateral margins elevated dorsally in the female.

Orthotype: *Strongylovelia formosa* sp. nov.

The nearest ally to this genus is *Halovelia* Bergroth. These genera appear to be of the family Veliidæ in shape, but in reality, belong to the family Gerridæ.

Strongylovelia formosa sp. nov.

Body pitchy black, coarsely but thickly punctured. Head black, transverse, with two small, ill-defined, pale brown spots along each inner margin of eye. Eyes large, brown, much produced laterally. Antennæ black with first joint white, first joint thicker than the others, slightly curved, second slightly longer than first, third very long and slender, about twice the length of first, fourth a little longer than first, moderately thickened towards the apex. Rostrum blackish brown with third joint longest.



Strongylovelia formosa n. sp., female. × 20.

Pronotum black, narrow. Meso- and metanotum together very much rounded and convex, almost hemispherical, black with a very broad, transverse white band whose posterior margin pointed anteriorly at the center. Prosternum black with two white, somewhat triangular spots. Mesosternum very broad, brownish black, with a large irregular band from lateral margin to center, posterior margin concave. Metasternum short, black. Anterior legs rather short, coxa black, short, trochanter white, twice as long as coxa; femur white with apical portion black, thickened, tibia about as long as femur, tarsus black, first joint very short, somewhat globular, second almost three times the length of first, claws situated at the center of second joint. Intermediate legs long, coxa short, black, trochanter much longer than twice the length of coxa, white; femur long, slightly tapering towards the apex, black with the base slightly whitish; tibia slender, shorter than femur, black;

tarsus very slender, black; first joint about one-half of tibia, second about half the length of first. Posterior legs much shorter than intermediate ones; coxa short, black, trochanter short, white, femur produced to the end of abdomen, white with apical one-third black; tibia slender, black about as long as femur, tarsus very short, black; first and second joints subequal in length, with two small claws at the apex. Abdomen rather short, black, considerably narrowed posteriorly; lateral margins elevated dorsally with long hairs in the female.

Length of body, female, 1.7 mm.

Holotype, female, collected by Mr. R. Takahashi, at Taihoku, Northern Formosa, on July 21, 1921, preserved in alcohol, is kept in my collection.

Two specimens of this beautiful insect were captured by him in a small pool at Taihoku; the one is the holotype and the other is being preserved in his collection. He told me that the insect must be extremely rare and as a matter of fact he has not yet come across a third specimen.

THE GENUS LIMOTHRIPS (THYSANOPTERA) IN AMERICA.

GLENN W. HERRICK.

In J. R. Watson's recent Synopsis and Catalog of the Thysanoptera of North America (1923), two species of the genus Limothrips are listed, namely, *L. angulicornis* Jablon and *L. cerealium* Haliday, both European species with representatives in this country. The first species, *angulicornis*, was discovered by P. R. Jones in California on Fox-tail grass and described (1912) as *L. setariæ*. The second species was recorded by Hinds from Massachusetts and Pennsylvania on oats and

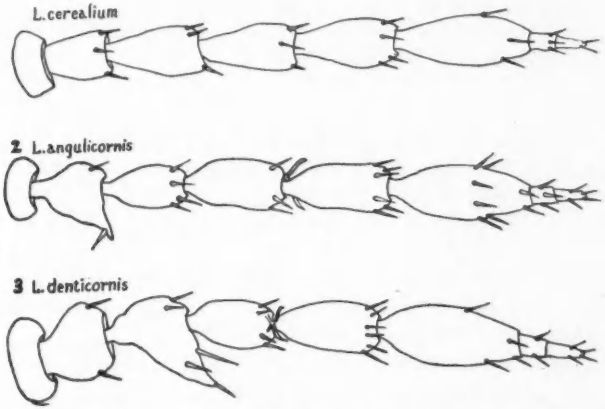


Fig. (1) *L. cerealium* (2) *L. angulicornis* (3) *L. denticornis*. (Original.)

Festuca pratensis and described (1902) as a new species, *L. avenæ*. We now have a third species of the genus, *Limothrips denticornis* Haliday (1836), in America, taken from wheat and from the nests of robins and sparrows.

The three species are easily separated by characters plainly noted in the antennæ. The segments of each antenna of *cerealium* are all of simple and normal form (Fig. 1), while the second segment of each antenna of *angulicornis* is conspicuously modified in form, being drawn out into a prominent, acute

triangular process on the outer angle, (Fig. 2). In the case of *denticornis*, the third segment of each antenna is modified in a similar but even more pronounced manner, (Fig. 3). The key to the species of the genus will then stand as follows:

A. Antennal segments normal in form.....*cerealium*
AA. Antennal segments, 2 or 3, abnormal in form.
b. Antennal segment 2 drawn out into a prominent, acute triangular process on the outer angle.....*angulicornis*
bb. Antennal segment 3 drawn out into a prominent, acute triangular process on the outer angle.....*denticornis*

The antennæ of *L. denticornis* are rather stout, and uniformly seal brown except the second segment, which is dark brown and the first, which has a dark band around the distal end. Segment 1 is short and thick; segment 2 longer and somewhat urn-shaped; segment 3 large, drawn out into an acute triangular process at the outer angle with a short, sharp spine on the outer tip of the triangular process and a much longer spine half way between the outer spine and the base of segment 4; segment 4 somewhat fusiform; segment 5 clavate, segment 6 fusiform; 7 and 8 slender and cylindrical. A forked sense cone on distal end of segment 4; the other sense cones are rather large and conspicuous but all simple.

A male and female were taken from wheat in June, 1923, by Mr. Donald Ries and later, in February and March, females were taken from the deserted nests of both robins and sparrows by Miss I. D. Dobroscky, all in the vicinity of Ithaca, New York. This thrips is a dark and fairly stout species, the winter specimens from the birds' nests being noticeably darker and stouter than the summer form on wheat. The wings are fairly heavy and distinctly yellowish-brown.

It should be noted that there is a fourth species of the genus, *L. schmutzi*, called to my attention by Mr. J. D. Hood, specimens of which I have not seen. It has not yet been found in this country so far as I know.

REFERENCES.

1923. Watson, J. R. Synopsis and Catalog of the Thysanoptera of North America. Fla. Agr. Expt. Sta., bul. 168, p. 31
1912. Jones, P. R. Some new California and Georgia Thysanoptera. U. S. Dept. Agr., Bu. Ent., Tech. Bull. 23, Pt. I, p. 8.
1902. Hinds, W. E. Monograph of the Thysanoptera. Proc. U. S. Nat. Mus., Vol. 26, p. 139.
1836. Haliday, A. H. The Entomological Magazine, Vol. III, p. 445.

Albert D. MacGillivray